NOTICE OF PROPOSED COST PASS-THROUGH FOR NETWORK SUPPORT PROVIDED BY MACQUARIE GENERATION

Notice and explanatory material

7 December 2007

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NOTIFICATION OF PROPOSED COST PASS-THROUGH FOR NETWORK SUPPORT SERVICE

In accordance with clause 6.2.4(b) of the National Electricity Code, the Australian Competition and Consumer Commission (ACCC), in a Decision dated 27 April 2005, set a revenue cap to apply to TransGrid for the regulatory control period from 1 July 2004 to 30 June 2009.

The *National Electricity (South Australia) (New National Electricity Law) Amendment Act* 2005 was passed in connection with the transfer of functions from the ACCC to the AER and section 10 of that Act provided for the making of regulations to address transitional issues. Clause 13 of Schedule 2 of the *National Electricity (South Australia) Regulations* in effect puts the AER in the shoes of the ACCC for the purposes of the ACCC's Decision.

Appendix A of the Decision contains Pass-Through Rules (the Pass-Through Rules) to apply as part of the Revenue Cap.

The Pass-Through Rules provide that a Pass-Through Event can be a Network (Grid) Support Event and that:

> A Network (Grid) Support Event occurs where the cost of network support becomes materially higher or lower than the per annum cost of network support (if any) provided by the ACCC in the Revenue Cap.[1]
>
> Pass-Through Amount means a variation to the TNSP's Maximum Allowed Revenue as a result of a Pass-Through Event determined in accordance with these Pass-Through Rules (which form part of the TNSP's Revenue Cap). A Pass-Through Amount may be positive or negative.

In accordance with clause 3.2 of the Pass-Through Rules, TransGrid provides the following Notice of Proposed Pass-Through:

<u>Table 1: Notice of Proposed Pass-Through</u>

Notice Requirement (see cl 3.2 of the Pass-Through Rules)	TransGrid Notification
(a) description of the relevant Pass-Through Event	There are two Pass-Through Events both of which are Network (Grid) Support Events: • Event 1: The materially higher cost incurred by TransGrid for network support resulting from the obligation to make a payment to Macquarie Generation of $5 million on 1 July 2007 for network support. • Event 2: The materially higher cost incurred by TransGrid for network support resulting from the obligation to make a payment to Macquarie Generation of $25 million on 1 April 2009 for network support.

[1] An example is provided which is not relevant in the current circumstances.

Notice Requirement (see cl 3.2 of the Pass-Through Rules)		TransGrid Notification
(b)	the date on which the relevant Pass-Through Event took effect or will take effect	• Event 1: 1 July 2007 • Event 2: 1 April 2009
(c)	if Notice of Proposed Pass-Through is provided under clause 3.1(d), the date on which the TSNP first became aware that the Pass-Through Event had taken effect or will take effect.	Not applicable. Notice of the Proposed Pass-Through is not provided under clause 3.1(d).
(d)	the estimated financial effect of the Pass-Through Event on the TNSP's provision of *prescribed services* (being the proposed Pass Through Amount)	• Event 1: $5,733,649 in the financial year 2008/09 • Event 2: $24,782,670 in the financial year 2008/09
(e)	the proposed period over which the Pass-Through Amount should apply	• Event 1: the financial year 1 July 2008 to 30 June 2009 • Event 2: the financial year 1 July 2008 to 30 June 2009
(f)	if the proposed period over which the Pass-Through Amount should apply consists of two or more financial years, the proposed allocation of the Pass-Through Amount over the financial years	Not applicable. The proposed period does not consist of two or more financial years.
(g)	the supporting information referred to in clauses 3.3(a) and (b)	See Table 2

Table 2: Supporting Information Required by the Pass-Through Rules to Accompany the Notice

Supporting Information (see cl 3.3 (a) and (b) of the Pass-Through Rules)		TransGrid Information
(a)	The TNSP must attach to its Notice of Proposed Pass-Through such information and documentation as the AER requires to enable the AER to form an opinion as to:	
(i)	whether the Pass-Through Event did take effect or will take effect	TransGrid has a contractual obligation to make payments to Macquarie Generation for provision of network support in the 2004-2009 Regulatory Period. Attached Schedule 1 is a summary of the payment amounts and dates from the Agreement with Macquarie Generation. This information is to be treated as "Commercial-in-Confidence"

Supporting Information (see cl 3.3 (a) and (b) of the Pass-Through Rules)		TransGrid Information
(ii)	if the Notice of Proposed Pass-Through is provided under clause 3.1(d), whether the TNSP complied with the requirement to give promptly such Notice to the AER.	Not applicable. Notice of the Proposed Pass-Through is not provided under clause 3.1(d).
(iii)	whether, and to what extent, the TNSP's MAR should be varied as a result of the Pass-Through Event (being the Pass-Through Amount).	Amount to be paid to Macquarie Generation for network support and associated TransGrid costs as set out in Table 1, Item(d): $30,516,319. Amount provided for in the ACCC Revenue Cap for network support: Nil Material increase: $30,516,319.
(iv)	the period over which the Pass-Through Amount should apply	The Agreement with Macquarie Generation was executed on 1st June 2007. It was too late to include the costs of Event 1 in the customer charges for 2007-2008 so these will need to be recovered in the 2008-2009 financial year. It is now evident that the costs of Event 2 will be incurred in the 2008-2009 financial year and these can therefore be passed through in the year in which they will be incurred.
(v)	if the proposed period over which the Pass-Through Amount should apply consists of two or more financial years, how the Pass-Through Amount should be allocated over the financial years	Not applicable. The proposed period does not consist of two or more financial years.
(b)	Without limiting the generality of the obligation in clause 3.3(a), the supporting information must include, where the Pass-Through amount is:	
(i)	a Change in Taxes Event…	Not applicable. This is not a Change in Tax Event.
(ii)	an Insurance Event…	Not applicable. This is not an Insurance Event.

Supporting Information (see cl 3.3 (a) and (b) of the Pass-Through Rules)	TransGrid Information
(iii) a Network (Grid) Support Event – if applicable, the relevant decision of NEMMCO or other Authority before the Network (Grid) Support Event and the relevant decision of NEMMCO or other Authority implementing the Network (Grid) Support Event.	Not applicable. The Network (Grid) Support Event did not occur because of a decision by NEMMCO or another authority. Neither NEMMCO nor other Authority is required to make a decision in relation to this Network (Grid) Support Event.
(iv) a Service Standards Event…	Not applicable. This is not a Service Standard Event.

It should be noted that the total payments associated with the Network (Grid) Support described in this Notice are spread over two Regulatory Periods. The total amount that TransGrid is seeking to recover is approximately $52 million. This Notice seeks to recover $30,516,319 in this Regulatory Period. The remaining $21 million (approximately) will be included in TransGrid's next Revenue Cap application for the 2009 - 2014 Regulatory Period.

EXPLANATORY MATERIAL

This explanatory material does not form part of the Notification of Proposed Cost Pass-through for Network Support Service, but is provided to assist the AER's understanding of the need for, and nature of, the Network Support Service

1. Summary of the need for Network Support Payments

TransGrid is implementing an integrated set of capital works known collectively as the "Western 500 kV Conversion" project. This project will maintain the ability of TransGrid's transmission network to transfer sufficient power from power stations within and outside NSW to meet the forecast peak power demands in the Newcastle, Sydney and Wollongong urban complex from 2008/09. In particular the project will allow more power to be transmitted to this urban complex from power stations that are located in the north of NSW, and in Queensland. Having regard for the demand and the location of the available power sources TransGrid has assessed that if this project is not implemented there will be insufficient power available to the urban complex from all sources under probable generator dispatch conditions from that date onwards.

The Western 500 kV Conversion project comprises a large number of inter-related works that will raise the operating voltage of a major transmission path within TransGrid's network from 330kV to 500kV. This transmission path extends from Bayswater in the north to Bannaby, near Marulan. The works include 500/330 kV substations that will create interfaces between the new 500 kV network and the existing 330 kV network.

At the northern terminal at Bayswater Power Station, which is owned by Macquarie Generation, the project includes reconnecting two of the four 660 MW generating units from the 330kV network to the 500kV network. This is to be achieved by replacing the generator transformers for these two generating units (designated as units 3 & 4) with transformers that have a 500kV secondary voltage, instead of the present 330 kV. There are several technical reasons for doing this, and these will be explained later. Each generating unit has two half-sized transformers, as this is the largest size that can be transported. Because the new transformers will be of a special design that is not a stock item it will be necessary to manufacture and locate a spare transformer on site. Accordingly Macquarie Generation will purchase five half-sized transformers in total.

As for all Power Stations in NSW, and in most other jurisdictions, the generator transformers are located on the power station property, and are owned and operated by the Generator owner, Macquarie Generation. Consequently only Macquarie Generation can authorise their reconnection and contract for the replacement equipment and works.

For this reason TransGrid has negotiated a contract with Macquarie to achieve the reconnection. This contract provides for Macquarie Generation to change the generator transformers and reconnect to TransGrid's 500 kV network, and for TransGrid to pay Macquarie's costs by staged payments. These will correspond to payment for preparatory works, followed by two payments corresponding to the disconnection of each of the generators from the 330 kV system and a final payment that will reconcile actual costs against the project estimate.

The National Electricity Rules provide that a TNSP can implement a non network option as an alternative to network augmentation. Where the cost of a network support service is not included in the Revenue Cap it can be passed-through under the Pass-Through Rules set out at Appendix A to TransGrid's Revenue Cap Decision.

The mechanism for recovery of these costs under the regulatory arrangements is therefore for them to be recognised as a Network Support service. The payments will then be classed as an operating expense that will be passed through to network customers through TransGrid's transmission network service charges.

There is no mechanism for these assets to be classed as transmission network assets whose costs would be recovered in the same manner as capital expenditure by a Network Service Provider, and the AER has advised TransGrid that it favours the proposed approach.

2. Purpose of this explanatory material

TransGrid has aimed to assemble and present to the AER information that will allow it to understand the background to the Western 500 kV Conversion project as a whole, so as to place the Pass-through Notification into perspective. TransGrid does not expect that the AER will review the merits of the project as a whole, for which TransGrid relies entirely on the existing ex ante capex arrangements that currently apply to it.

The background material therefore explains TransGrid's assessment of its ability to meet its reliability requirements as demand increases into the future, and the role that the Network Service that is the subject of this Notification will play. In addition the document includes appendices that are mostly extracts from publicly-available papers that summarise the processes that TransGrid has undertaken.

3. TransGrid's Regulatory Framework

As a transmission network service provider, TransGrid is subject to two forms of regulation:

1 Jurisdictional arrangements and the National Electricity Rules (the Rules) that set minimum reliability standards that must be met. Investment to met these standards is subject to economic discipline as investment must be undertaken at a reasonable cost; and

2 Rate of return regulation that allows a TNSP to invest in the network but only where it is economically justifiable based on a Regulatory Test.

Minimum reliability standards are set by each jurisdiction having regard for its assessment of the importance of electricity to the economy. Network owners are required to meet these reliability standards.

Investment required to meet those standards is not second guessed within the regulatory structure except to the extent that the least cost means of achieving reliability should be adopted. This requirement is set out in the reliability limb of the regulatory test.

The Bayswater arrangements are for reliability purposes and therefore a cost benefit analysis of TransGrid not meeting its reliability requirements is not relevant.

Of course TransGrid seeks to meet its reliability standards efficiently. The background material explains TransGrid's assessment of its ability to meet its reliability requirements where demand is increasing into the future.

In particular, the appendices to this Explanatory Material summarise the network planning process whereby TransGrid has:

1 forecast demand;

2 assessed the ability of its transmission network capability to meet forecast demand;

3 identified limitations in the network;

4 considered options to relieve limitations and meet forecast demand;

5 undertaken a more detailed analysis of practicable options;

6 applied the regulatory test to the practicable options; and

7 taken steps to implement the least cost option.

The regulatory process ensures that these steps have been subject to checks and balances including consulting all Registered Participants, NEMMCO and interested parties in accordance with clause 5.6.6 of the Rules. The findings in TransGrid's' Final Report were not disputed or referred to the AER. A copy of TransGrid's Final Report can be found in Appendix 12 or on TransGrid's web site http://www.transgrid.com.au/trim/trim224993.pdf .

4. Background to the Western 500 kV Conversion Project

4.1. Reason for providing this information

The Notice of Proposed Cost Pass-through for Network Support provided by Macquarie Generation relates to the purchase of a service that will add to the effectiveness and efficiency of a major capital works project that is being undertaken by TransGrid, namely the Western 500 kV Conversion project.

The estimated cost of providing this Network Service was included in the Regulatory Test analysis of the Western 500 kV Conversion Project, and it was an integral part of the best-ranked option. This project is therefore a pre-requisite for the Network Support service. The reason for providing the information in this section is to give the reader an appreciation of the general nature of that project in a form that might assist the understanding of the background and rationale for the Network Support service.

4.2. Load disposition and growth in NSW

The Newcastle/ Sydney/ Wollongong area that is referred to in this document includes the Sydney CBD and the major industrial areas of Sydney, Newcastle and Wollongong. This is the major commercial and political hub of NSW.

At the time of peak NSW demand the load in this area accounts for over 75% of the State's power demand. The area also accounts for about a third of the total demand in the interconnected southeast Australian (NEM) system.

The consumption of energy and the maximum demand for electricity in NSW have both shown a steady growth over the last 60 years - driven by population growth and increasing per capita electricity usage. Even allowing for new consumption management initiatives being identified by the community and implemented to slow the rate of growth, TransGrid has forecast, on the basis of authoritative economic forecasts, that both energy consumption and maximum demand will continue to increase for the foreseeable future.

Details of forecasting process, the NSW demand forecast and existing and forecast demand in the Newcastle/ Sydney/ Wollongong area can be found in Appendix 1.

4.3. TransGrid's transmission development obligations

TransGrid has obligations under the National Electricity Rules and jurisdictional requirements to develop the NSW electricity transmission system to ensure that there is sufficient transmission capacity to meet the NSW State demand at an acceptable standard of reliability from the output of generators within the State and from interconnection capacity. In doing so, it is essential that the transmission system be developed so that in the longer term it can manage a range of generation development and market dispatch scenarios.

Details of the criteria that TransGrid uses in planning its transmission network can be found in Appendix 2.

The planning criteria that apply to the NSW main system, including the western 500 kV conversion project, are set out in TransGrid's APR. The criteria are essentially 'N-1' taking into account the manner in which the interconnected system is operated by NEMMCO.

In summary the criteria are categorised into a set of criteria that apply at the 50% probability of exceedence load forecast level and a set that apply at the 10% probability of exceedence load forecast level, as follows:

Peak demand at or exceeding a one in two year probability of occurrence (50% probability of exceedence)
The system will be able to operate securely[2] under all reasonably probable patterns of generation dispatch or interconnection power flow.

In the event of a forced outage of any single item of plant[3], the system will be able to be re-secured by the re-dispatch of generation but without load shedding.

In planning reactive plant installations provision is made for the prior outage of a single capacitor bank.

Peak demand at or exceeding a one in ten year probability of occurrence (10% probability of exceedence)

The system will be able to operate securely under a limited set of patterns of generation dispatch or interconnection power flow.

In the event of a forced outage of any single item of plant, the system will be able to be re-secured by the re-dispatch of generation but without load shedding.

The non-network alternatives to supply reinforcement to meet the above criteria include load control, which can take the form of load shedding in anticipation of a contingency or in response to a contingency. In these cases a contractual arrangement is put in place, together with automatic or manual control schemes (or System Protection Schemes) to give effect to the load shedding. The contractual arrangement provides for the financial compensation to the owner of the load for providing the load control service. There is no conflict here with the need to satisfy the 'N-1' criteria.

These criteria ensure that there is sufficient transmission capacity so that load will not be pre-emptively shed in anticipation of a contingency or shed following a first contingency. They relate to the way in which the system is operated by NEMMCO.

NEMMCO's Operating Practice

These criteria directly relate to NEMMCO's operating practice with respect to ensuring that the system is secure (refer to the National Electricity Rules). NEMMCO's practice is to re-secure the system through the re-dispatch of generation or load shedding following a contingency, with the use of load shedding as the last resort. The difference between TransGrid's planning criteria and NEMMCO's security criteria is that TransGrid applies the above as reliability criteria, with the need to ensure that pre-emptive load shedding is not required.

4.4. Description of the "core" NSW transmission network

The "core" portion of the NSW transmission network that is identified in diagram 1 on the next page supplies the Newcastle/ Sydney/ Wollongong load area, which is also identified. The main energy sources for this area are the power stations that are located to the north, west and south of Sydney. These power stations comprise:

- In the north: Bayswater and Liddell power stations, together with some smaller stations and transfer from Queensland;
- In the west: Mt Piper and Wallerawang power stations, plus some small hydro and wind generators;
- In the south: the Snowy power stations, some smaller hydro and wind generators, and transfer from Victoria.

[2] The term "securely" here is the common interpretation of system security by power system planners – it implies that in anticipation of the next most critical contingency all network elements are loaded to within their thermal ratings, voltages are stable and there is an adequate margin from the point of voltage instability, the system is transiently stable and the modes of oscillation are adequately damped.
[3] In this context a single item of plant is defined as a single transmission circuit, a single generating unit, a single transformer or a single item of reactive plant.

- Within the load area, on the central coast between Newcastle and Sydney: Vales Point, Munmorah and Eraring Power Stations.

The core transmission network comprises high capacity 330 kV transmission lines using both single circuit and double circuit construction, together with three very high capacity double circuit 500 kV lines, one of which operates at its design voltage, while two others operate at 330 kV.

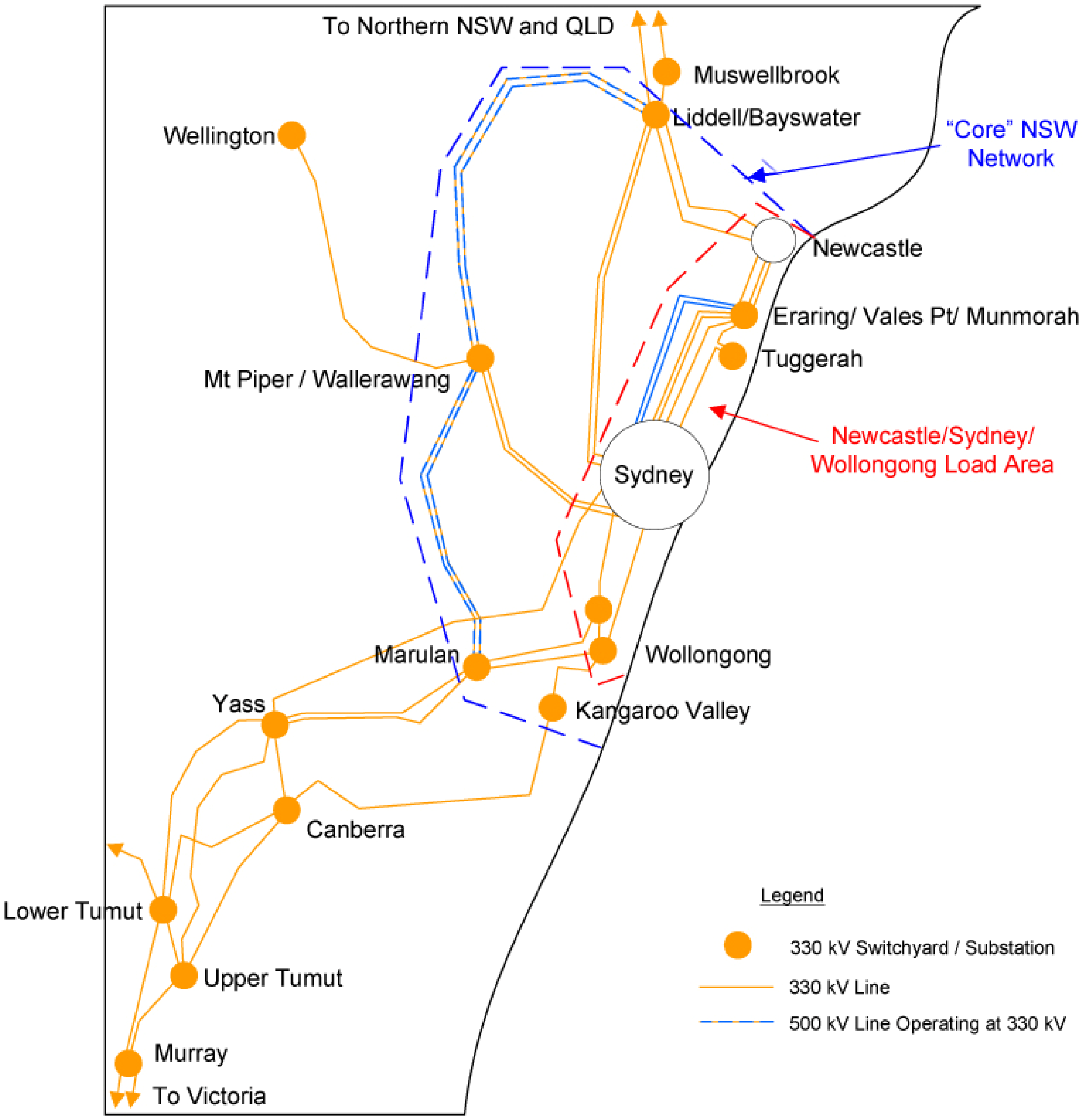

Diagram 1 – Portion of the NSW Network showing the "core" and the Newcastle/ Sydney/ Wollongong Area

At periods of high demand in the load area the power transfer on these lines is predominantly in the direction from the power stations towards the load area. The relative amounts of transfer on the various transmission paths that can be seen on this diagram depends upon the electrical characteristics of the paths and the output powers of the stations as determined by NEMMCO's central dispatch.

As a consequence some of these paths carry more power relative to the capacity of the transmission lines than others. At times the dispatch patterns of generators might need to be changed to prevent one path from being overloaded, while others still have the capacity to accept additional power transfer.

There are a number of locations in NSW where the short circuit level is high and approaching the rating of substation plant. This will need to be addressed as new generating capacity is added to the network. This is particularly the case at the Bayswater and Liddell 330 kV switchyards. The conversion of the western lines to 500 kV operation marginally increases the short circuit levels at the switchyards, but the transfer of Bayswater generating units to the 500 kV network will reduce them.

4.5. TransGrid's long-term transmission planning concept

There are environmental and social constraints on new line development in NSW. TransGrid is required to act in an environmentally and socially responsible manner. The principles that TransGrid applies for the augmentation of transmission capacity are:

- The development should be consistent with the outline plan for the system, in order to minimise the proliferation of lines;
- National parks will be avoided where other reasonable options exist, as this is not considered environmentally responsible and it is also not considered feasible to obtain environmental approval for such developments;
- It is necessary to avoid multiple disturbances to an area;
- Maximum use should be made of scarce line routes;
- Substation development is preferred over line development; and
- The relatively high cost of line development should be deferred as much as possible by the use of reactive plant;

The concept of developing a strong 500kV ring around Newcastle/ Sydney/ Wollongong area was developed in the 1970s and partially implemented through the 1980s and early 1990s. The aim of the concept is to provide for substantial future needs to transmit power from remote power stations to load areas, while minimising transmission line routes into the Sydney basin and effectively managing technical constraints (fault levels) on switch gear.

Three stages of the 500kV development have already been completed. The first stage was the construction of the Eraring to Kemps Creek 500kV double circuit line, which provided for the reliable connection of Eraring Power Station to Sydney. The next stage of the 500kV network development was construction of the Bayswater to Mt Piper 500kV line, which was required to connect Bayswater Power Station in the mid to late 1980s. The third stage of the 500kV network was construction of the Mt Piper to Marulan 500kV line to match the commissioning of the Mt Piper Power Station in the early 1990s.

At the time of construction it was most efficient for the Bayswater to Mt Piper and the Mt Piper to Marulan 500kV lines to be connected to operate initially at 330kV. However provision was made for their operation at the design voltage when justified by network requirements.

TransGrid considers that new lines would not be able to be developed to address the immediate needs of the supply to the Newcastle/ Sydney/ Wollongong load corridor, while ever there is another option available. However as the load grows and is to be met by generation development outside of the load corridor it is inevitable that new line development will eventually be required.

TransGrid is undertaking the conversion of the western 500 kV system from 330 kV to 500 kV operation as this requires substation development with no new line developments. This conversion project will maximize the capability of the existing transmission network.

As a part of the overall strategy for a 500 kV ring network the western 500 kV conversion project is underpinning further network developments to accommodate the following generation developments:

- Hunter Valley generation and generation north of the Hunter Valley;
- Western generation developments;
- Generation developments in the Marulan area or further south;
- Increased power transfers over the NSW – Queensland interconnection; and
- Increased transfers over the NSW – Snowy – Victoria interconnections

The need for further reinforcement of supply to the load corridor would be deferred only by significant committed generation or demand management development within the load corridor.

For the Revenue Reset in 2008 a large number of new future generation planting and load growth scenarios are being assessed. These all show the need for reinforcement of the transmission network to supply to the Newcastle/ Sydney/ Wollongong load corridor.

4.6. Forecast onset of network constraints

In its current configuration the NSW electricity transmission network has limited capacity to provide reliable access to load centres from additional generation that will need to be installed in the future to meet the NEM reliability standards. At periods of peak summer demand in the near future generating units connected outside the Newcastle - Sydney - Wollongong load centres will more frequently be constrained off by the limitations in transmission line capacity to these major load centres. The connection of additional generators within this load area is also severely restricted by the fault interrupting capability of the major equipment within those areas, and in practical terms by the environmental constraints on significant quantities of new (non-distributed) generation being sited on the coastal strip.

The transmission capability within the "core" NSW network is limited by two factors:

- The thermal rating of the transmission lines, particularly under high ambient temperature conditions; and
- The ability to control voltage at all points on the network to within acceptable limits for customers and to maintain the integrity of the overall system.

In particular the existing "core" NSW electricity transmission network is reaching the limit of its capacity to reliably supply power to the Newcastle - Sydney - Wollongong load area under high load conditions. The two limitations being addressed by the Western 500 kV conversion project are:

- The thermal rating of the Liddell – Newcastle / Tomago 330 kV line. Under peak summer demand and credible dispatch conditions the outage of either of the lines leads to a high loading on the remaining line. As the net input to the load corridor grows as a result of growth in the load corridor the loading on the remaining line increases. The time is about to be reached when the thermal rating of the line is reached, and with additional growth the line rating would be exceeded. In this case load will need to be shed if the network is not augmented.
- Voltage control limitations. The transfer of increasing levels of power into the load corridor causes a reduction the ability to adequately control voltage levels across the NSW main system and particularly in the Sydney area. When the maximum power transfer capability is reached it is necessary to shed load to maintain the integrity of the supply system.

These network limitations are illustrated in Diagram 2.

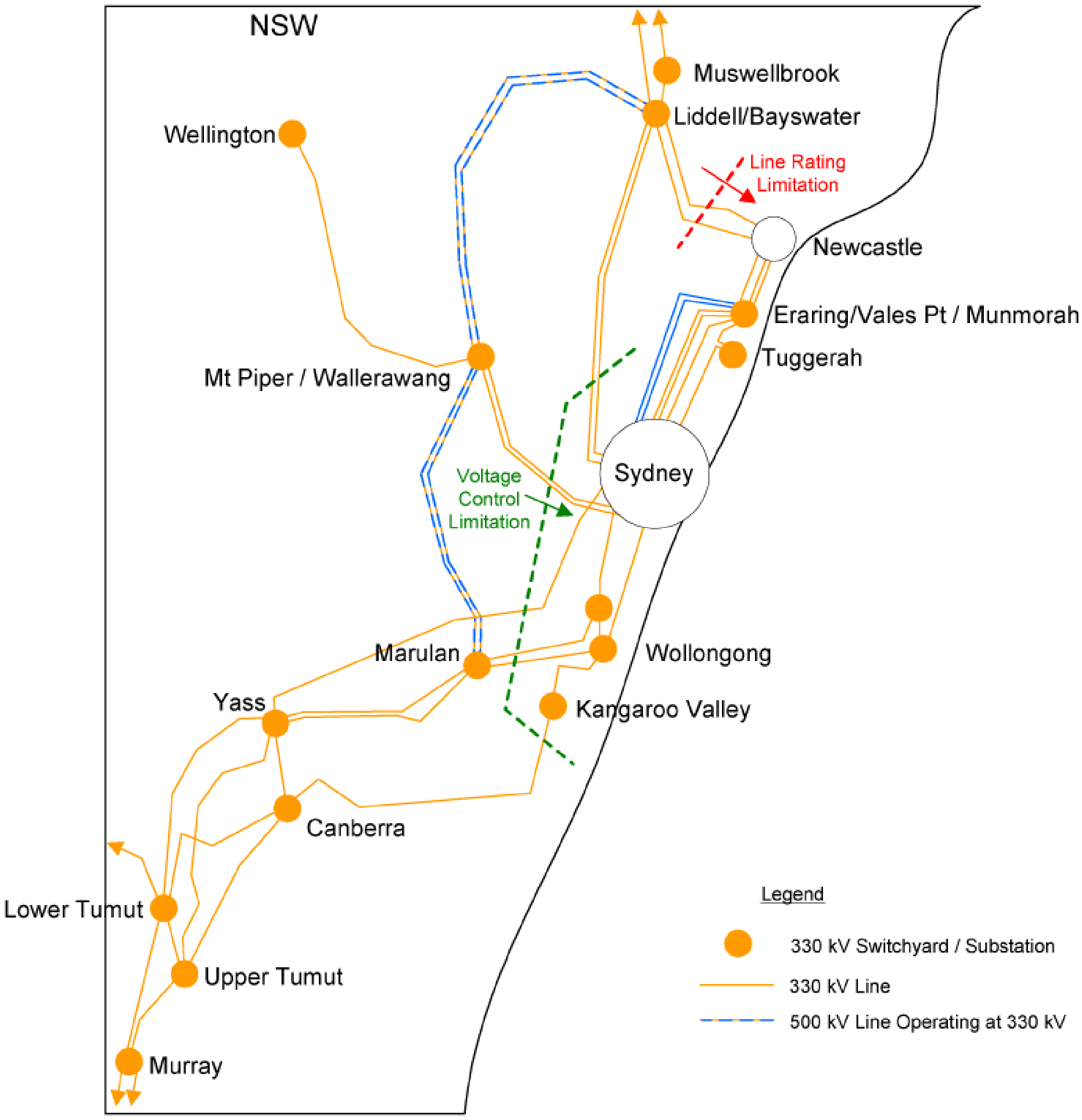

Diagram 2 - Transmission Network Limitations

There are three paths for power transfer from the northern power stations[4] towards the load area: a direct route to Sydney, a route via Newcastle and the central coast power stations, and a route to the west on the 500 kV lines that operate at 330 kV.

The power transfer on these paths is not proportional to the relative transmission capacity on these routes, but is determined by the electrical characteristics of the paths and physical laws. It is also affected by the distribution of the demand within the load area, and the dispatch of all the generation.

The 330 kV transmission line rating between Liddell and Newcastle becomes especially critical when the following conditions arise:

- The demand in the load area is at or near the summer peak, so that
- There is a need to dispatch most of the generation that is available to the load area; but
- One or more of the central coast generating units is unavailable, or the power output is significantly reduced for technical reasons, causing the net load that is required to be supplied via the transmission network to increase.

If one of the two 330 kV lines from Liddell to Newcastle was to come out of service under these conditions all the power that it was carrying will transfer to the other transmission paths. However

[4] Liddell and Bayswater power stations plus smaller stations and Queensland import

because of the physical characteristics most of it will transfer to the parallel line, so causing it to become overloaded. To avoid this condition the NEMMCO central dispatch system will automatically limit the output of the northern generators to a safe level.

Hence the unavailability of the central coast generating unit will be exacerbated by a limitation on the output of the northern generation to avoid the line overload. If the load and generation combination is near that which is set by the NEM reliability criterion for the NSW region there will be insufficient transmission capacity to supply the area load, thus violating the reliability requirements set by the NSW jurisdiction.

TransGrid must plan to develop its transmission network so that this condition will be avoided.

More detail of these constraints is given in Appendix 3.

4.7. Planned transmission network augmentation

As the load continues to grow, augmentation of this network is required to provide reliable supply to the Newcastle/ Sydney/ Wollongong area. The further development of the strong 500kV ring around this area is now planned to address the emerging transmission constraints. This development will alter power flow sharing between the paths to reduce the loading on the 330kV lines between the Hunter Valley power stations and the Newcastle area.

TransGrid's Western 500 kV conversion development will change the electrical characteristics of the western path so that it will carry a much larger share of the total output of the northern power stations. This will avoid overload of the line to Newcastle and allow the full output of the northern and western power stations to be dispatched irrespective of the availability or dispatch status of the central coast power stations.

The proposed development is the fourth stage of the establishment of a strong 500kV ring around the load area. It does not require the construction of new 500 kV lines, but involves the conversion of two existing transmission lines that are currently operating at 330kV (Bayswater - Mt Piper and Mt Piper - Marulan), to their design operating voltage of 500 kV.

To achieve this conversion the 500 kV lines must be interfaced with the 330 kV system. The development therefore includes:

- The construction of 500 kV switchyards and 500/330 kV tie transformers adjacent to Bayswater and Mt Piper power stations,
- The construction of a 500/330kV substation at Wollar to augment supply to the west of the State, and
- The construction of a 500/330kV substation at Bannaby (near Marulan) to give access to lines towards Sydney from the south.

It is a significant investment in transmission infrastructure with an estimated total cost of approximately $370 million and with completion planned for 2009-10.

This development also supports voltages in the Newcastle/ Sydney/ Wollongong area, which was identified in the previous section as another emerging limitation to power transmission. It achieves this by reducing reactive power losses, providing additional "line charging" and increasing access to the reactive power capability of power stations in the Hunter Valley and in the Mt Piper/ Wallerawang area.

The Western 500kV Conversion will significantly increase the capacity of the core NSW transmission system to deliver power to the State.

It will also ensure that efficient and competitive National Electricity Market (NEM) operation is maintained, although this factor is not considered within the reliability limb of the Regulatory Test.

4.8. Application of the Regulatory Test

In developing this project TransGrid has considered a number of non-network and network options to address the forecast reliability issues, as required by Clause 5.6.6 of the Rules. Details of the options considered are given in Appendix 4.

TransGrid engaged NERA Consulting to apply the Regulatory Test to these alternatives. Because the primary driver for the development is the reliability of transmitted supply to the Newcastle/ Sydney/ Wollongong load area NERA applied the reliability limb of the Test. Details of the application of the Test by NERA are in Appendix 6.

When applying the regulatory test, NERA Consulting found that only two options would meet the minimum network performance requirements across a range of realistic market development scenarios. Both options involve the conversion of the Bayswater – Mount Piper – Bannaby system to operate at its design voltage of 500kV (Western 500kV Conversion).

Both options include elements of Network Support Service[5] that would defer the 500 kV conversion works for one or two years. Because an increased amount of this service is required for the second year of deferral the conclusion of the Test is that a one year deferral is the best-ranked option under the Test.

The network development component for the best-ranked option in the majority of scenarios (NERA Option B) is shown in Diagram 3.

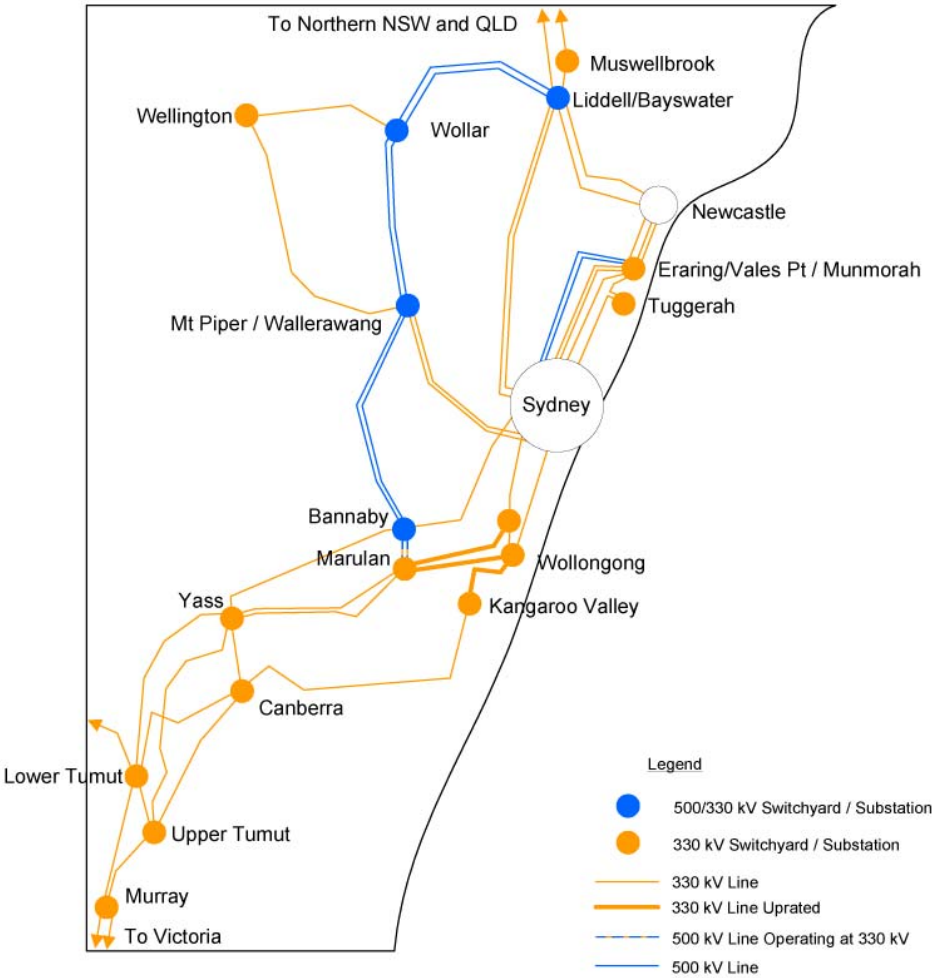

Diagram 3 – Network upon completion of "The Western 500kV Conversion"

5 These are not the network support services referred to in this Application. They are different services that are aimed at ensuring that additional generation will be available to the load area to match the transmission deficiency.

A copy of NERA's Report can be found in full in Appendix 13 or on TransGrid's web site http://www.transgrid.com.au/trim/trim224991.pdf .

5. The Bayswater Network Support Proposal

5.1. Need for the Proposal

Connection of the Bayswater generating units 3 and 4 to the 500 kV switchyard moves these generators directly on to the western 500 kV lines and makes them more remote (electrically) from the 330 kV system that connects the Hunter Valley to the coast and Sydney.

Hence there will be a higher power flow from Bayswater to Mt Piper and Bannaby and lower power flow on the more heavily-loaded 330 kV lines from the Hunter Valley to Newcastle and Tomago.

The power flow is effectively diverted so as to enter the Sydney area from the west and south rather than the north.

The project evaluated by NERA included the estimated costs associated with disconnecting two Bayswater generating units from the 330 kV network, and reconnecting them to the 500 kV network.

If the Bayswater generating units 3 and 4 were to remain connected to the 330 kV switchyard at Bayswater there would only be a partial relief in the loading on the 330 kV lines to Newcastle and Tomago. Hence the line rating of the critical 330 kV lines between Liddell and Newcastle and Tomago would more readily form a bottleneck to power flow from the Hunter Valley to the load corridor. This bottleneck would be a constraint on the ability to supply the load in the load corridor from generators in the north of the State and in Queensland.

In its Final Report on the application of the regulatory test, TransGrid explored the option of leaving the Bayswater Units 3 and 4 connected to the Bayswater 330kV Switchyard. TransGrid Option 1 incorporates reconnection of Bayswater Units 3 and 4 to the 500kV switchyard while TransGrid Option 2 leaves these generators connected to the 330kV switchyard (see Appendix 4).

Planning analysis of these two options (see Section 5.2 of this document and Appendix 5) shows that reconnecting Bayswater Units 3 and 4 to the 500kV switchyard will increase the transmission network capacity to meet the peak Newcastle/ Sydney/ Wollongong area demand by between 165MW and 195MW under the studied system conditions[6]. This assessment considers all other sources of generation and transmission capacity to meet the load.

The Network Support service at Bayswater is therefore necessary to realise the full benefits of the Western 500kV Conversion and is an integral part of TransGrid Option 1 and NERA Option B[7], which was the least cost option that satisfied that regulatory test.

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[6] Under the study conditions described in section 5.2 the figure is 180 MW, which is an average benefit.

[7] The options considered by TransGrid (TransGrid Options) differ from the Options considered by NERA (NERA Options). NERA Options are made up of combinations of TransGrid Options. To distinguish between the two in this document, TransGrid Options have been labelled numerically while NERA Options have been labelled alphabetically. Detail on TransGrid Options can be found in Appendix 4. Detail of NERA Options can be found in Appendix 6.

5.2. Other options for Bayswater Switchyard Connections

Seven options were considered for the generator connection arrangement at Bayswater. These are described in Table 5.1 and are later assessed in terms of capability, cost and feasibility.

Option	Connection arrangements
1	Only the Bayswater unit 4 is connected to the 500 kV switchyard
2	All four of the Bayswater generating units remain connected to the 330 kV switchyard
3	All four of the Bayswater generating units remain connected to the 330 kV switchyard, and series reactors are applied to the Liddell / Newcastle 330 kV lines
4	All four of the Bayswater generating units remain connected to the 330 kV switchyard and a third 500/330 kV transformer is installed in parallel with the planned two 500/330 kV transformers.
5	Three Bayswater units are connected to the 500 kV switchyard
6	Four Bayswater units are connected to the 500 kV switchyard
7	330/500 kV transformers are inserted in series with each of the unit 3 and unit 4 generator transformers

Table 5.1: Bayswater options considered

The maximum power transfer capability of the western 500 kV conversion project is illustrated in Figures 1A and 1B below for system normal and single contingency (one line out of service) conditions. These diagrams relate only to the line rating limitation on supply to the Newcastle/ Sydney/ Wollongong load corridor from the north. Figures 1A and 1B are used as the base case to demonstrate the difference between the western 500 kV conversion project and the other options.

In diagram 4 below Figure 1A shows a system normal power flow condition for summer 2008/9 in the connections to the Hunter Valley power stations. All of the line loadings are within the line ratings.

Figure 1B shows the impact of an outage of the Liddell – Tomago 330 kV line where the loading in the Liddell – Newcastle 330 kV line reaches about 1456 MW which is equivalent to a loading of 1400 MVA (at the nominal voltage). This loading is about 98% of the line rating of 1430 MVA.

In developing figure 1B it is assumed that the additional system losses following a line outage would be dispatched from generators in the north.

Because the loading on the Liddell – Newcastle line is below the line rating spare capacity exists. Hence in the summer of 2008/09 the western 500 kV conversion project would enable a higher level of load in the Newcastle/ Sydney/ Wollongong load corridor to be supplied from the north before the critical line would reach its rating of 1430 MVA.

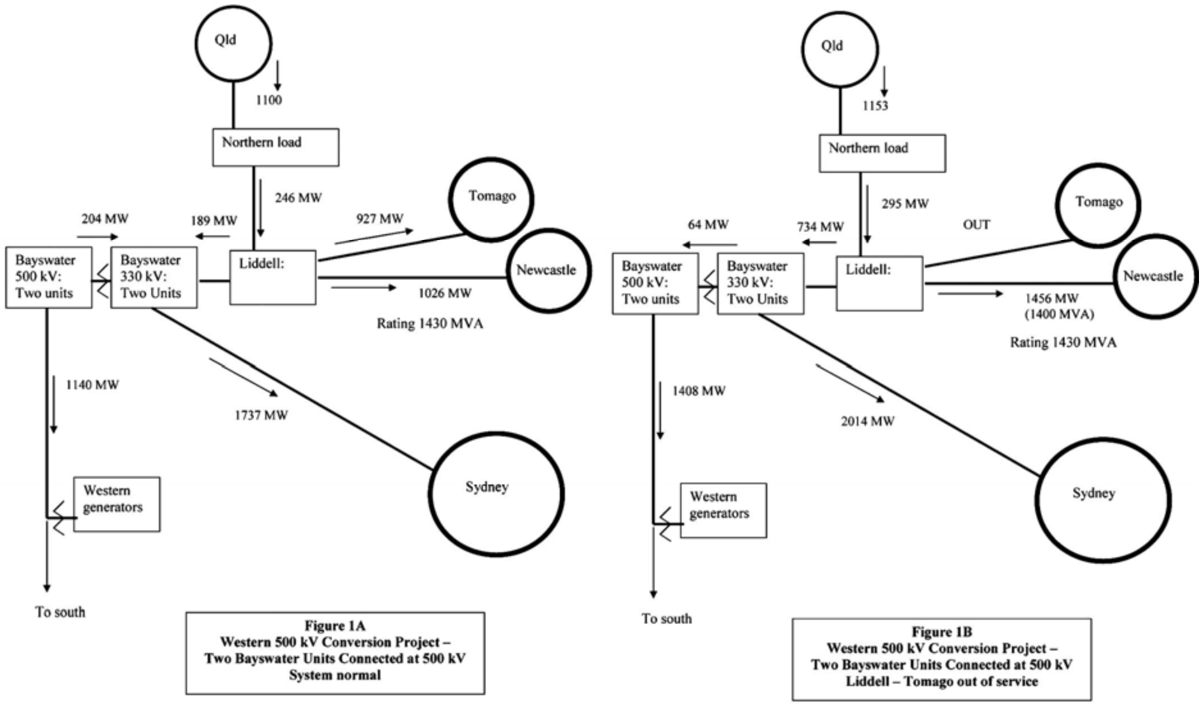


Diagram 4: Illustrative heavy loading conditions in lines from the north of NSW for the base-case Western 500 kV Conversion

The addition of load in the Newcastle/ Sydney/ Wollongong load corridor would increase the loading in the Liddell – Newcastle line if the increment in load was to be supplied from the Hunter Valley or further north. Incrementally for every 3 MW of load supplied in the load corridor from the north the loading in the Liddell – Newcastle line increases by approximately 1 MVA. This 3:1 ratio gives an approximate guide, with respect to line thermal rating, for comparing other development options to the western 500 kV conversion project, in terms of the ability to supply the corridor load.

These power flows are illustrative of typical power flow conditions with high power flow from the north of the State and reduced power flow from the south of the State. Other generation patterns need to be allowed for but the above example is used as the base or reference case to illustrate the differences between the development options with respect to line rating limitations.

Planning of the NSW main system takes into account all of the existing and committed generation sources. This includes all the power stations in the Hunter Valley, west, Central Coast, south and interconnectors. The generation dispatch condition in table 5.2 was used in developing these figures:

Power station or interconnection flow	Units On-line	Station generation (at the generator terminals)
QNI		1100 MW import to NSW
Terranora		0 MW transfer
Bayswater	4	2800 MW
Liddell	4	2060 MW
Redbank	1	148 MW
Mt Piper	2	1320 MW
Wallerawang	2	1000 MW
Eraring	4	2640 MW
Vales Pt	2	1320 MW
Munmorah (existing units)	1	300 MW

Table 5.2: Generator power output assumptions

In this example all of the base-load units are in service and at high output except that one of the existing Munmorah coal-fired units is assumed out of service. The Munmorah coal-fired units are the oldest and smallest of the NSW coal-fired units.

The remainder of the demand in the Newcastle/ Sydney/ Wollongong corridor is met by high dispatch of generators in the south of the State, and the maximum permitted transfer from Snowy and Victoria. Under the study conditions this is constrained by network conditions in the south of the State. Accordingly an inability to dispatch all generation in the north of the State will result in a need for load shedding in the corridor.

5.2.1. Bayswater Option 1: Only Bayswater unit 4 is connected to the 500 kV switchyard

Figures 2A and 2B in diagram 5 show the corresponding situations when only one of the Bayswater generators is connected to the 500 kV switchyard.

Figure 2B shows that the power flow on the Liddell – Newcastle line is at the line rating. Hence this option provides just enough capability to meet the load at the time under the power system conditions examined.

To reduce the line loading to the value in the reference case the total dispatch of generation at Liddell and to the north would have to be reduced by about 90 MW, and this amount of load would have to be shed in the Newcastle/ Sydney/ Wollongong corridor if it could not be replaced by higher dispatch from generation in the south of the State, as assumed in the study.

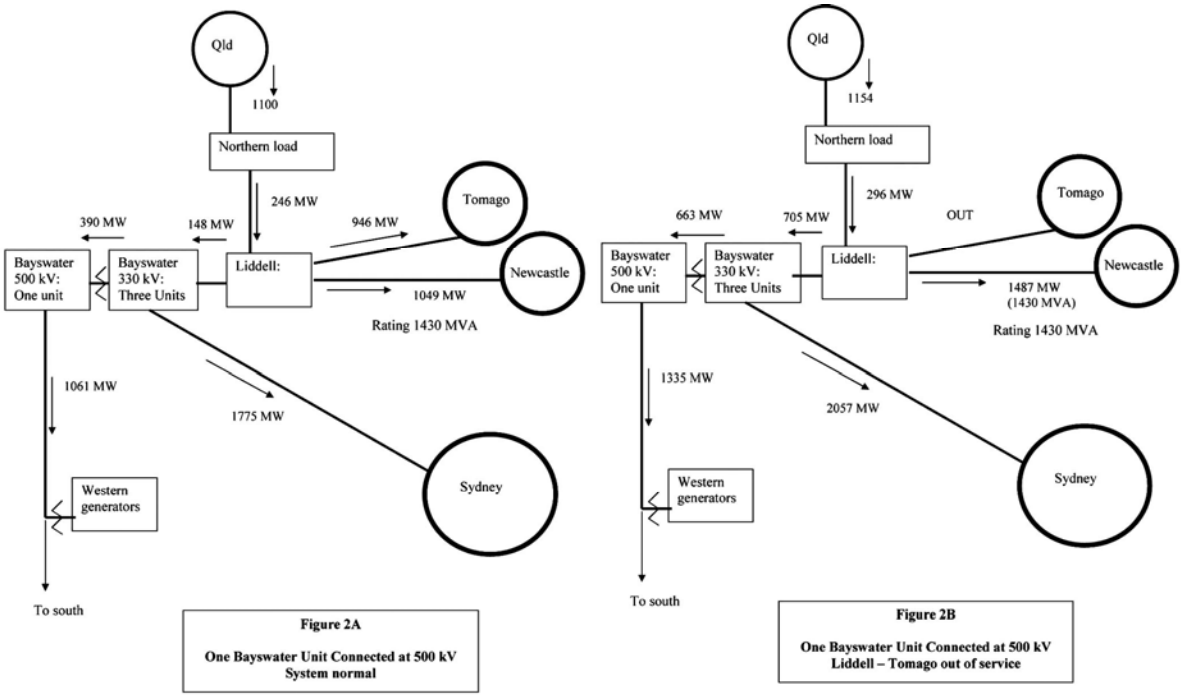


Diagram 5: Illustrative heavy loading conditions in lines from the north of NSW for Option 1 - Only Bayswater unit 4 connected to the 500 kV switchyard

5.2.2. Bayswater Option 2: Four generating units connected to the Bayswater 330 kV switchyard

Figures 3A and 3B of diagram 6 show the corresponding situations when all of the Bayswater generators remain connected to the 330 kV switchyard.

Figure 3B shows that the power flow on the Liddell – Newcastle line exceeds the line rating. Hence this option does not provide the capability to meet the load at the time.

To reduce the line loading to the value in the reference case the total dispatch of generation at Liddell and to the north would have to be reduced by about 180 MW, and this amount of load would have to be shed in the Newcastle/ Sydney/ Wollongong corridor if it could not be replaced by higher dispatch from generation in the south of the State, as assumed in the study.

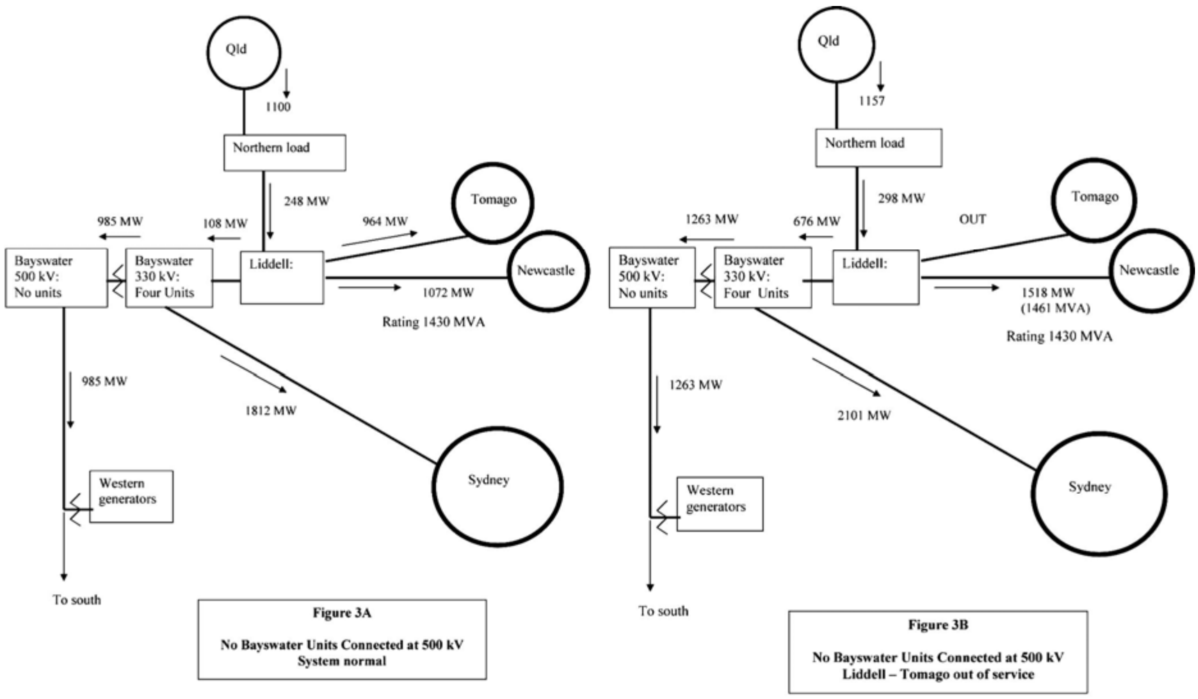


Diagram 6: Illustrative heavy loading conditions in lines from the north of NSW for Option 2 - All four Bayswater generating units remain connected to the 330 kV switchyard

The short-circuit rating of the Bayswater and Liddell 330 kV switchyards is 50kA. If all of the Bayswater units remain connected to the 330 kV bus then the short circuit levels at Bayswater and Liddell become close to the rating with approximate values of:

	Three-phase kA	Single-phase kA
Bayswater	49.1	52
Liddell	48.3	49.7

Table 5.3 Fault levels at Bayswater and Liddell for Bayswater option 2

In accordance with good industry practice remedial works would be expected to be required at Bayswater to address the single-phase fault level issue.

This option would therefore also require remedial works to enable the connection of any additional generating sources in the northern area of the State.

The base case and option A would not require immediate remedial works on account of excessive fault levels.

5.2.3. Bayswater Option 3: All four Bayswater generating units remain connected to the 330 kV switchyard, and series reactors are applied to the Liddell to Newcastle and Tomago 330 kV lines

Option 3 is an extension of option 2 in which series reactors have been assumed installed in the Liddell – Newcastle / Tomago lines to improve the distribution of power flows shown in Figure 3B. The impedance of the reactors has been chosen to enable a post-contingency power flow in the Liddell – Newcastle line which is comparable with that of Figure 1B.

The corresponding power flow diagrams are shown in Figures 4A and 4B of diagram 7.

In Figure 4B the power flow in the Liddell – Newcastle line is about 1390 MVA, which is slightly lower than that in the reference case in Figure 1B. This means only that the assumed reactor impedance in the study was marginally too high, and it would not result in a material difference to the cost estimate.

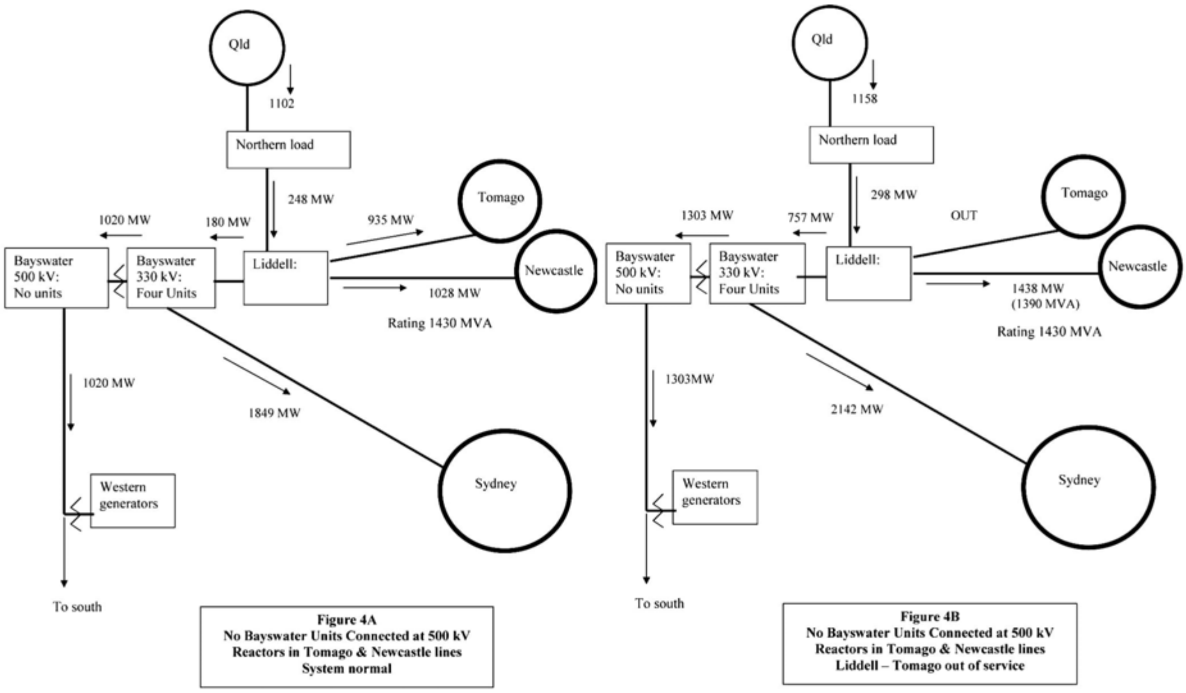


Diagram 7: Illustrative heavy loading conditions in lines from the north of NSW for Option 3 - All four of the Bayswater generating units remain connected to the 330 kV switchyard, and series reactors are applied to the Liddell – Newcastle and Tomago 330 kV lines

Reactors would be required to increase the impedance of each of the Liddell – Tomago and Liddell – Newcastle lines so that an outage of either line would not cause the other to be overloaded.

In addition a spare reactor would be required to avoid significant constraints on supply should one reactor fail.

The cost of this option is approximately $46 million +/- 30%.

The purchase, delivery and installation of the reactors would result in a delay to the project, which would then involve additional costs for Network Support.

The benefits of this option would erode over time compared to the western 500 kV conversion project and the reactors would become redundant with the commissioning of the next stage of the 500 kV network.

5.2.4. Bayswater Option 4: All four Bayswater generating units remain connected to the 330 kV switchyard and a third 500/330 kV transformer is installed at Bayswater

Option 4 is also an extension of option 2, in which an additional 500/330 kV transformer has been assumed installed at Bayswater in an attempt to improve the distribution of power flows shown in Figure 3B.

The corresponding power flow diagrams are shown in Figures 5A and 5B of diagram 8.

In Figure 5B the power flow in the Liddell – Newcastle line still exceeds the line rating.

To reduce the line loading to the value in the reference case the total dispatch of generation at Liddell and to the north would have to be reduced by about 120 MW, and this amount of load would have to be shed in the Newcastle/ Sydney/ Wollongong corridor if it could not be replaced by higher dispatch from generation in the south of the State, as assumed in the study.

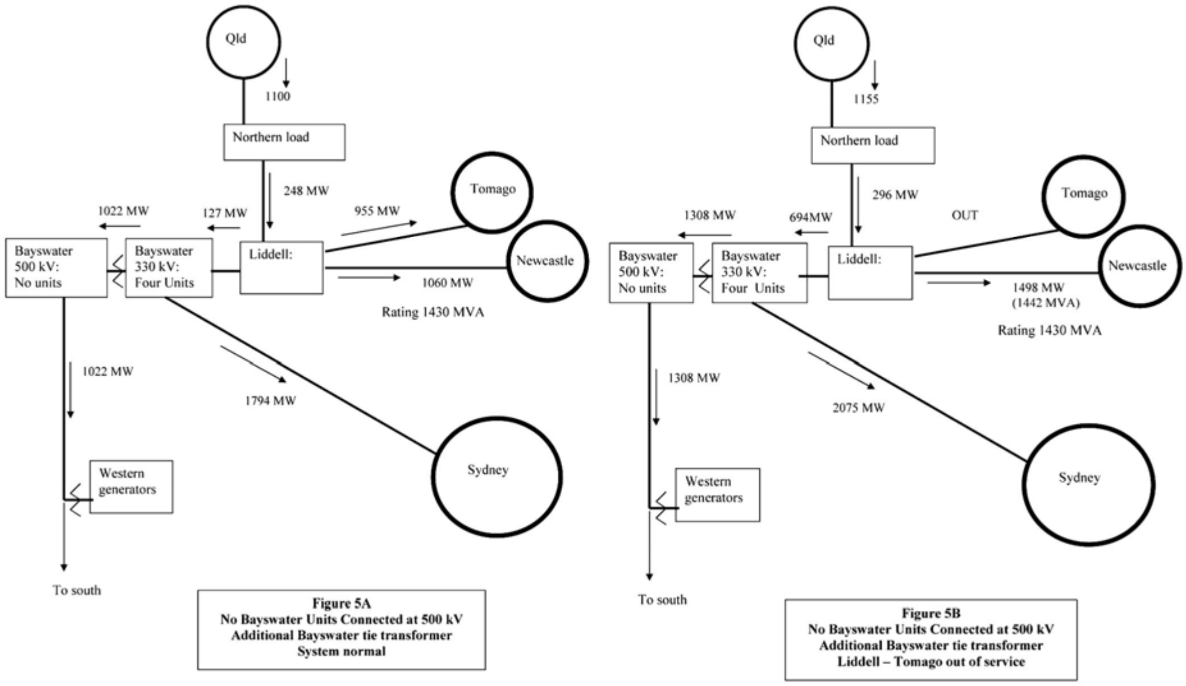


Diagram 8: Illustrative heavy loading conditions in lines from the north of NSW for Option 4 - All four of the Bayswater generating units remain connected to the 330 kV switchyard and a third 500/330 kV transformer is installed at Bayswater

There is not sufficient room for the third transformer in the present design of the Bayswater 500 kV switchyard. Hence additional cost would be incurred to extend the switchyard to incorporate the third transformer.

5.2.5. Bayswater Options 5 and 6: Three or four Bayswater units connected to the 500 kV switchyard

In terms of power flow capability and impact on the short circuit levels on the 330 kV system there would be advantages in reconnecting three or four of the Bayswater generating units to the 500 kV switchyard.

However it is not considered an acceptably reliable arrangement to have more than two of the Bayswater generators connected to the 500 kV bus following the conversion of the western system to 500 kV operation. The arrangement provides the following connections to the units that are connected at 500 kV:

- Two circuits on a double circuit 500 kV line from Bayswater to Mt Piper, over a distance of about 220 km; and
- Two 500/330 kV tie transformers at Bayswater.

The Bayswater generators are base-load units and an outage of one of the 500/330 kV transformers (either as a result of a trip of a transformer or as required for transformer maintenance) would require significant constraints on the generator output. The reason for these constraints is that it is not considered feasible to operate more than two units at full output over the long line to Mt Piper without a connection back to the 330 kV network.

The transfer of more than two of the generators to the 500 kV switchyard therefore would require additional 500/330 kV transformers at Bayswater to provide adequate security. In addition the resulting higher flows from Bayswater to the south would probably also require additional transformer capacity at Bannaby. There would be costs additional to those incurred for the change in generator transformers.

For these reasons options 5 and 6 are not considered feasible and have been rejected.

The transfer of additional generating units to the 500 kV network is likely to be required at the stage where additional power stations are developed in the north of the State and a 500 kV line is developed from the Hunter Valley to the coast.

5.2.6. Bayswater Option 7: 330/500 kV transformers in series with unit 3 and unit 4 generator transformers at Bayswater

Electrically this arrangement is similar to the re-connection of the generating units 3 & 4 to the 500 kV switchyard.

The cost has been estimated at $60 million +/-30%.

The purchase of the transformers at this stage would cause a delay in the project.

The additional impedance to the generators due to the 500/330 kV connecting transformers would be likely to have a deleterious impact on interstate power transfer capability governed by transient stability considerations, though the magnitude of the impact has not been quantified.

Further, the arrangement would be less reliable, because the inherent transformer failure rate would double.

Hence this option is inferior to the western 500 kV conversion project on both cost and technical grounds.

5.2.7. Overall Comparison of Bayswater Options

The table 5.4 below compares the options with the western 500 kV conversion project.

Option	Cost compared to western 500 kV conversion project	MW benefit to load corridor, compared to western 500 kV conversion project (approximate) - Note 1	Feasibility
1	Lower – by the value of one generator transformer	-90	Feasible
2	Lower – by the value of two generator transformers	-180	Feasible but requires remedial works to manage the Bayswater fault level
3	Similar initial cost but line series reactors redundant at next stage of 500 kV development	60	Feasible but delay to project
4	Higher	-120	Additional space requirements
5&6	Higher	Greater	Not feasible
7	Higher	0	Feasible

Table 5.4: Comparison of Bayswater options with the western 500 kV conversion project.

Note 1: This figure is the adjustment required to the total MW dispatch of the generators at Liddell and to the north (including Queensland import) to reduce the critical line loading to the value that applies in the base western 500 kV conversion project. If this dispatch cannot be replaced by generation in the south of NSW it is the amount of corridor demand that would have to be shed to satisfy the constraint.

Options 1, 2 and 4 provide less support to the load corridor than does the western 500 kV conversion project.

In addition option 2 has a limited life due to the short circuit level issues because one or more generators would need to be transferred to 500 kV operation at the stage of the next northern power station development.

Option 4 has a higher cost and cannot be readily accommodated at Bayswater.

Options 5 and 6 have been evaluated as being infeasible.

Only option 3 could be designed to provide the same capability as the western 500 kV conversion project. However its cost is similar (slightly higher) to the western 500 kV conversion project, it would delay the project and has a shorter life than the western 500 kV conversion project, which has an ongoing benefit. Hence this option is considered inferior to the western 500 kV conversion project.

The western 500 kV conversion project, with Bayswater units 3 and 4 both reconnected to the 500 kV switchyard is technically feasible, represents good industry practice and provides the highest capability at the lowest cost.

5.3. Project being implemented at Bayswater

The western 500 kV conversion project includes the reconnection of the Bayswater units 3 & 4 to the 500 kV switchyard.

The changes that are being implemented at Bayswater are illustrated in the figure on the next page.

TransGrid, as part of the Western 500 kV Conversion capex project, will:

- Construct a new 500 kV switchyard adjacent to its current 330 kV switchyard;
- Connect the two switchyards together using two 500/330 kV tie transformers; and
- Reconnect the existing line to Mt Piper and Marulan from the 330 kV switchyard to the 500 kV switchyard.

Under the Contract for Network Support Macquarie generation will, in sequence for units 3 and 4:

- Disconnect the two 330 kV generating unit transformers from TransGrid's 330 kV switchyard and from the generators and remove them from the site;
- Install a pair of new 500 kV generator transformers, and connect them to the generator and TransGrid's 500 kV switchyard.
- Acquire a spare 500 kV generator transformer, and locate it for ready replacement of any of the above transformers.

The final result will be that units 3 and 4 will be permanently connected directly to the 500 kV network, and their outputs will not pass through the 330/500 kV tie transformers. Consequently more of their output will be transmitted over the 500 kV lines to the Newcastle, Sydney and Wollongong urban complex, so reducing the power transfers over the other 330 kV paths.

The changes that will be made at Bayswater are illustrated in Diagram 9.

It is reasonable for Macquarie Generation to purchase a spare transformer, because the spare transformer for the existing transformers will not be useable. Macquarie must continue to provide for the failure of one of the transformers that provides its 330 kV connection, and therefore there is no net gain when Macquarie Generation acquires a spare generator transformer for connection to the 500 kV network.

Failure of either of the two in-service generator transformers per generating unit would halve the generating capability of that generating unit until the transformer could be repaired or replaced. While transformer failure is a rare event, such transformers are not standard stock items, and would have to be manufactured to order. Depending on the location of the manufacturer and its manufacturing schedules it could therefore take many months – even years- to acquire a replacement. Commercial losses to Macquarie Generation resulting from reduced generating unit capacity during that period would far outweigh the cost of the spare transformer. Further, in a situation of close balance between demand and supply, the NSW region may not meet the NEM reliability standard over this period.

Based on 2006-07 average pool price of about $58/MWh for the NSW NEM Region, Macquarie Generation would expect to forego profit in excess of $40/MWh for generation that is not available. Failure of one of the two transformers would reduce the generating unit output by about 350MW. Based on an availability factor of 0.9, commercial losses over a 12 month period would be in excess of $110M. This far exceeds the cost of a spare generator transformer.

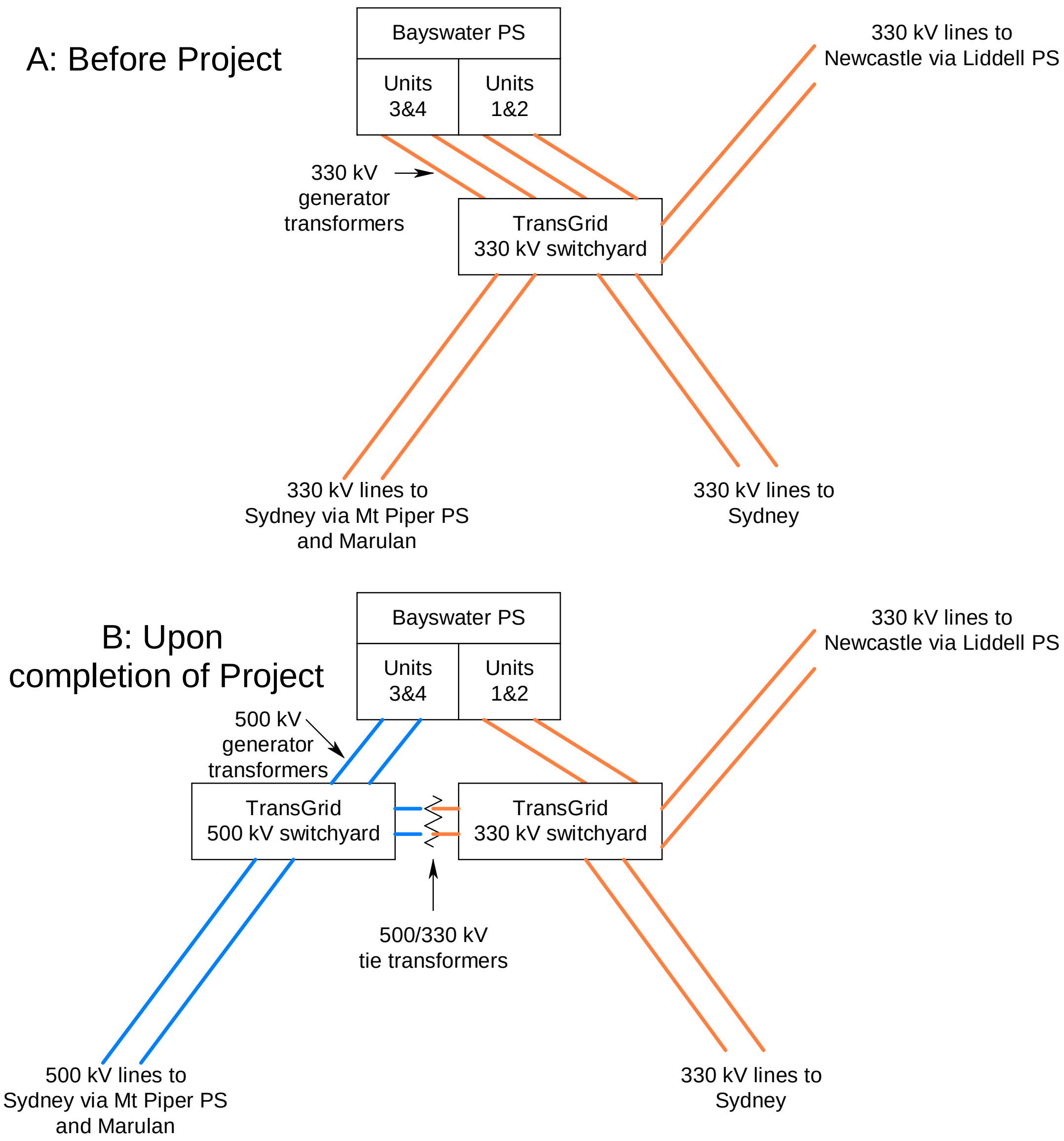


Diagram 9: Schematic showing the Bayswater PS connection and transmission arrangements before and after completion of the Western 500 kV conversion project.

Aerial photographs with schematic overlays indicating the work to be carried out at Bayswater are provided in Appendix 8. Diagrams showing the staging of works at Bayswater 330kV Switchyard and Bayswater 500kV Switchyard are provided in Appendix 9.

5.4. Costs and benefits to Macquarie Generation

The existing generator transformers at Bayswater Power Station are owned by Macquarie Generation. The connection point between Macquarie Generation's assets and TransGrid's assets is the connection at TransGrid's switchyard.

Replacement of the Bayswater Unit 3 and 4 generator transformers and associated backup transformer will be the responsibility of Macquarie Generation and it will own the new generator transformers.

Macquarie Generation will gain no net commercial benefit from the reconnection of generating units 3 & 4 because its dispatch costs are lower than several other power stations that are also affected by the constrained transmission. Hence Bayswater will continue to be dispatched, while other stations may be constrained off.

There is therefore no incentive for Macquarie to carry out this work if it does not receive Network Support payments.

Macquarie will remove from service four 330 kV generator transformers that are around 50% of the average life expectancy for this class of asset, and are not showing particular signs of deterioration. These will be replaced with new transformers, for which TransGrid, on behalf of network customers, will pay cost price based on a competitive tender (plus an allowance for project management).

Macquarie has agreed to accept the risk of foregone market opportunities associated with locking in a prolonged outage of each generator for the changeover, upon payment of an agreed premium. As a result the generating unit reconnection will take place at a time suited to TransGrid, rather than being able to be varied by Macquarie Generation to take advantage of perceived market opportunities.

6. Achieving efficient costs

6.1. Contract with Macquarie Generation

The Bayswater arrangements are for reliability purposes and therefore a cost benefit analysis of TransGrid not meeting its reliability requirements is not relevant. Of course TransGrid seeks to meet its reliability standards efficiently.

In accordance with the regulatory test, TransGrid has an obligation to ensure that the costs of activities are less than the cost of the next best alternative. It is not TransGrid's role to ascertain whether the costs of an unregulated entity such as Macquarie Generation costs are efficient.

TransGrid does not have an option to acquire this service by competitive tender because it is specific to the particular location and assets that are owned by Macquarie Generation.

Never-the-less TransGrid is conscientious and diligent in cost control and has negotiated an outcome with Macquarie Generation that best reflects actual market or efficient costs. In the absence of effective competition the best prospects of an efficient outcome in the context of a sole purchaser/ sole supplier circumstance was to negotiate with Macquarie Generation while holding TransGrid's commercial position and "bottom line" confidential.

The result of TransGrid's approach to the negotiations is that Macquarie Generation has agreed to a more cost effective solution for TransGrid, and therefore a lower pass-through, than Macquarie Generation would have had the bargaining position to obtain.

In particular, Macquarie Generation has agreed that its costs would be open to TransGrid's scrutiny. Two important cost control mechanisms were negotiated with Macquarie Generation:

1. An "open book" approach in which Macquarie Generation agreed to allow TransGrid access to all documentation relating to its costs associated with the project; and
2. Macquarie Generation has agreed to undertake an open competitive tendering process for purchase of the transformers.

TransGrid believes that the agreement with Macquarie Generation has achieved the least cost development.

6.2. Negotiations between TransGrid and Macquarie Generation

"Commercial-in-Confidence"

“Commercial-in-Confidence”

“Commercial-in-Confidence”

6.3. Macquarie Generation Costs

“Commercial-in-Confidence”

“Commercial-in-Confidence”

6.4. TransGrid's Costs

TransGrid has costs associated with its administration of the contract and pass-through arrangements. There are two components as summarised in table 6.2:

Description		Cost $M (note 3)
Financing charges (note 1)		0.400
Operating charges (note 2)		0.116
	Total	**$0.516**

Table 6.2: Summary of TransGrid's costs associated with the pass-through arrangements

Note 1. Financing Charges
TransGrid must make payments to Macquarie Generation a significant time before recovering these through the pass-through arrangements. TransGrid's financing charges take into account the time cost of money and have been calculated using 6.65% interest rate. This was the Reserve Bank of Australia published 90 day bill rate for 23rd October 2007.

Note 2. Operating Charges
TransGrid has already, and will in the future, incur cost related to the administration of the Agreement with Macquarie Generation.

Note 3: Rounding
All cost figures have been rounded to the nearest dollar.

Appendix 10 provides details of TransGrid's calculation of the pass-through amount for its costs.

7. Treatment of the Western 500kV Conversion in TransGrid's Revenue Reset Applications

At the time TransGrid's current revenue cap was set, TransGrid's expected capex for the Western 500kV conversion was taken into account but the allowance did not include some associated works at Bayswater because this proposed work was to be undertaken by Macquarie Generation. This is now explained in more detail.

In September 2003 TransGrid applied to the ACCC for a Revenue Reset Determination for the 2004 - 2009 Regulatory Period. This application was made under the ex-post regulatory regime for capex that existed at that time.

In this Application the Western 500 kV conversion was treated as a contingent project, and hence there was no allowance included in the ACCC's determination for any expenditure.

While the ACCC was considering TransGrid's application the regulatory framework was under review. During the review process, TransGrid became aware that the ACCC intended to change the regulatory framework for future capital expenditure to an ex-ante regime.

TransGrid wrote to the ACCC on 12th March 2004 (see Schedule 4) requesting permission to resubmit its Capex application in line with the proposed future regulatory regime. On 30th March 2004, the ACCC replied (see Schedule 4) and agreed to consider a revised Capex submission from TransGrid. At this time neither the ACCC nor TransGrid considered reopening TransGrid's Opex application.

Subsequently, in November 2004, TransGrid submitted a revised Application, which included a revised Transmission Capital Investment Program. In this program the western 500 kV conversion was included as a planned project, and the Revised Application provided for the estimated efficient capex for these TransGrid works.

This Revised Application did not include provision for an allowance for works associated with disconnection of the Bayswater Unit 3 and 4 from the Bayswater 330kV Switchyard and reconnection to the Bayswater 500kV Switchyard. TransGrid's revised capex proposal (November 2004 at pages 13 to 14 of Section 6 of the revised capex proposal) identified the need for new generator transformers as part of the project to upgrade the Bayswater-Mt Piper-Marulan System to 500kV operation and submitted that "the cost of the work does not include the cost of new generator transformers at Bayswater". TransGrid noted that it had not yet done the regulatory test but included the project in its capital budget as the work "must start soon".

The revised Application recognised that these assets are owned by Macquarie Generation, and it would be responsible for the cost of their replacement. It was considered that the costs of undertaking these works would be properly treated as a network service payment, which is an opex payment under the regulatory arrangements. As the Opex component of TransGrid's Revenue Reset Application was not reopened, no allowance was made in the Opex for recovery of expected Network Support payments.

It should be noted that while an amount for works associated with disconnection of the Bayswater Unit 3 and 4 from the Bayswater 330kV Switchyard and reconnection to the Bayswater 500kV Switchyard was not included in the revised capex submission, an allowance was made for the cost this work when the regulatory test was applied to this project by NERA Consulting.

On 5th April 2007, TransGrid wrote to the AER seeking advice on the appropriate mechanisms for recovery of amounts to be paid to Macquarie Generation for Network Support. Some of the amounts to be paid fall in the current regulatory period and some fall in the next regulatory period. In its response dated 10th May 2007, the AER advised that payments in this regulatory period should be covered by the Pass-Through-Rules under TransGrid's current Revenue Determination. A copy of this correspondence can be found in Schedule 5.

8. Additional Comments

As part of the wider regulatory process, TransGrid has considered the issues of materiality, efficiency and reasonableness. TransGrid considers the pass-through costs are:

- **Material**
  TransGrid has negotiated an agreement with Macquarie Generation for provision of network support at Bayswater Power Station. The network support is provided by transferring the connection point of Bayswater Units 3 and 4 from the Bayswater 330kV Switchyard to the Bayswater 500kV Switchyard.

  Payments to Macquarie Generation, as well as TransGrid's own costs, amount to $30,516,319 in the 2004 - 2009 Regulatory Period. This amount was not allowed for in TransGrid's revenue cap for that period.

  This amount is considered material.

- **Efficient**
  TransGrid has applied the regulatory test to the Western 500kV Conversion and the proposed network support is a component of the least cost option (NERA Option B) that satisfied that regulatory test.

  As described above TransGrid carried out extensive and rigorous negotiations with Macquarie Generation to ensure that cost of provision of the network support were minimised.

  TransGrid considers this expenditure is efficient.

- **Reasonable**
  Transfer of the connection point for Bayswater Units 3 and 4 from the 330kV Switchyard to the Bayswater 500kV Switchyard has satisfied the regulatory test. The alternatives, while technically feasible, would be more expensive and not good engineering practice.

  TransGrid considers it is reasonable to seek recovery of the expenditure associated with this network support.

A1 Appendix 1 - Existing and Forecast Demand in the Newcastle/ Sydney/ Wollongong Area

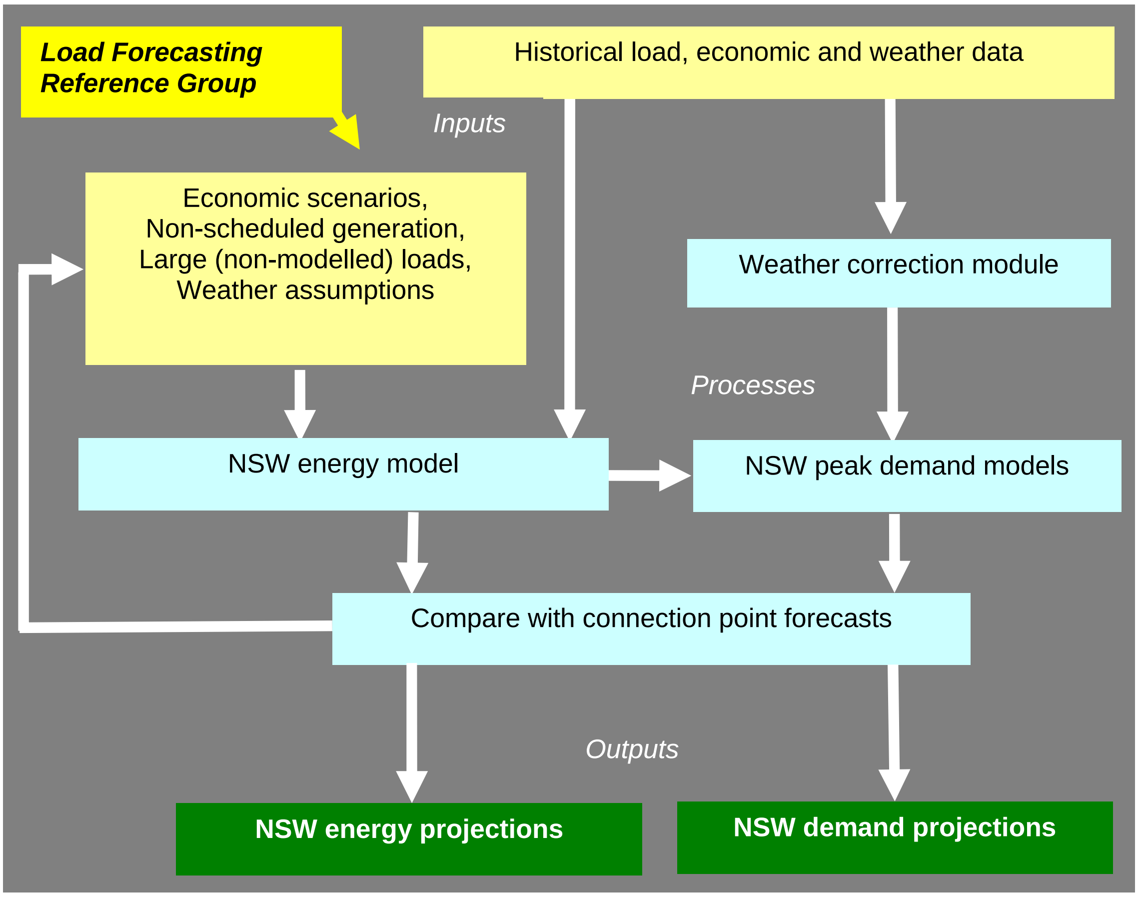
NOTE: 1. Information contained in this Appendix relating to TransGrid's forecasting methodology is based on TransGrid's current Annual Planning Report. This document can be found on TransGrid's web site http://www.transgrid.com.au/trim/trim242922.pdf

2. The information contained in this Appendix relating to demand forecasts in the Newcastle/ Sydney/ Wollongong area is based on Appendix 2 of TransGrid's "Final Report, Proposed New Large Transmission Network Asset, Development of Supply to the Newcastle - Sydney - Wollongong Area, October 2006". This document can be found in Appendix 12 or on TransGrid's web site http://www.transgrid.com.au/trim/trim224993.pdf

A1.1 TransGrid's Forecasting Methodology

The production of the energy and demand projections for the NSW region of the NEM is illustrated in Diagram A1.1 and the overall process is described below.

Diagram A1.1 TransGrid's Load Forecasting Processes



The NEM Load Forecasting Reference Group (LFRG) ensures that the regional energy and maximum demand projections throughout the NEM are developed by Jurisdictional Planning Bodies (JPBs) for inclusion in NEMMCO's Statement of Opportunities (SOO) on a consistent basis, by developing consistent definitions and assumptions. It is noted that TransGrid is the NSW Jurisdictional Planning Body.

Inputs to the overall process include the historical data that is used for estimating and testing the various models that are used and future scenarios for the independent variables in these models. Assumptions about the future, including the economic scenarios, are applied to the models to produce the NSW energy and demand projections.

Several statistical models have been developed by TransGrid, particularly:

- The energy model relates electrical energy to demographic, economic and weather variables.
- The weather correction module conducts analysis on historical demands and weather conditions to determine a probability distribution of demand for each season of each year, subject to a range of possible weather patterns. The 10th, 50th and 90th percentile of each distribution are selected as the historical series of demands that are projected into the future using the peak demand models.
- The peak demand models relate demand at the selected percentiles of the distribution to lagged demand and energy. Therefore, the projected demands from each model are implicitly at their respective percentile, or Probability of Exceedence (POE) level.

Forecasts of summer and winter demand at individual connection points are provided by EnergyAustralia, Integral Energy, Country Energy and Actew-AGL for their respective distribution network areas across New South Wales. These projections, which are assumed to represent approximate 50% POE demands, are aggregated by TransGrid incorporating appropriate allowances for network losses and time diversity of peak demands throughout the New South Wales region. These aggregates are then directly comparable with the modelled demands for New South Wales produced by TransGrid. An iterative process of re-examining the basis of both the TransGrid modelled projections and the connection point forecasts is undertaken to ensure compatibility.

A1.2 The Demand for Electricity in Newcastle/Sydney/ Wollongong

The “core” transmission network is facing limitations in supplying customer demand in the greater Newcastle area as well as in the Central Coast to Wollongong area. The nature of the demand for electricity in these two areas is described in the following Sections.

A1.3 Greater Newcastle Area

The load supplied in the greater Newcastle area include the electricity demand of the city and suburbs of Newcastle, the electricity demand supplied on the lower mid north coast from Newcastle (between Newcastle and Taree) and the aluminium smelter loads in the area. In recent years the growth in summer maximum demand for electricity has exceeded that of winter maximum demand. The maximum demand in summer and winter are now comparable.

Diagram A1.2 shows the maximum demand (averaged over a half hour period) for each day from 1 July 1996 to 19 September 2007. The average growth in summer maximum demand for electricity in the greater Newcastle area over this period has been approximately 1.5% p.a. despite major events in the area (such as changes to BHP’s operations).

Diagram A1.2 Daily Maximum Demand for Electricity in the Greater Newcastle Area

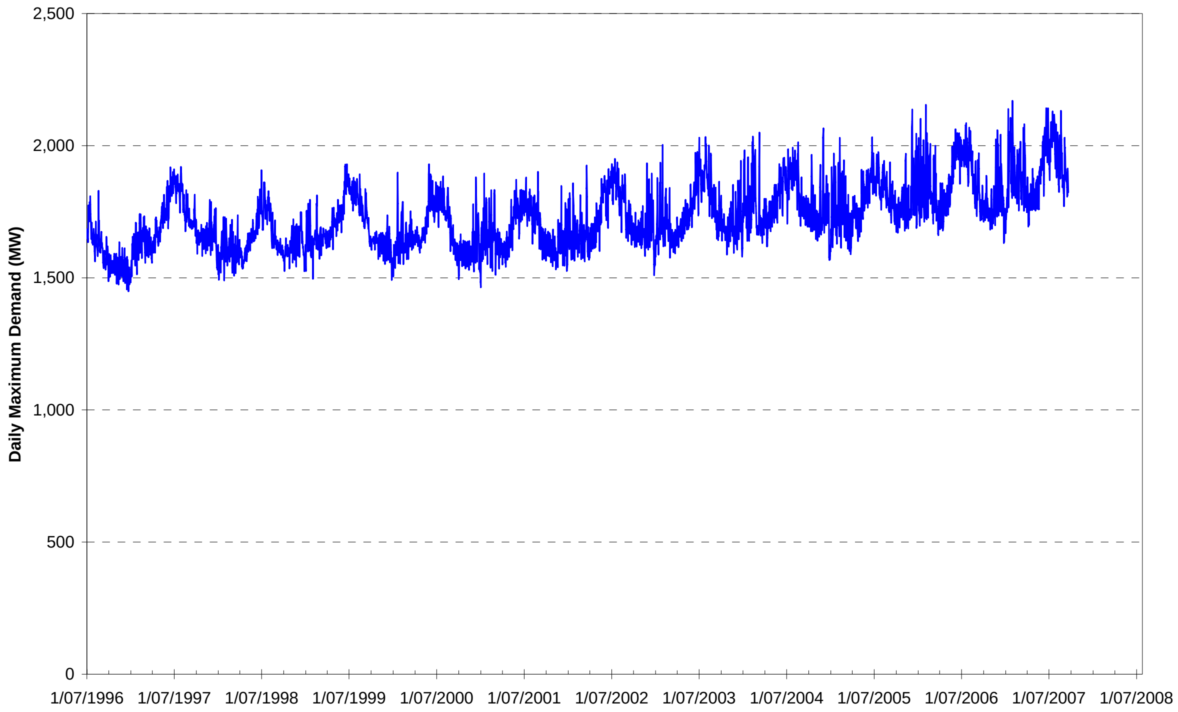


Diagram A1.3 shows typical profiles for the days of summer and winter maximum demand.

Diagram A1.3 Greater Newcastle Load Profiles on Day of Maximum Demand

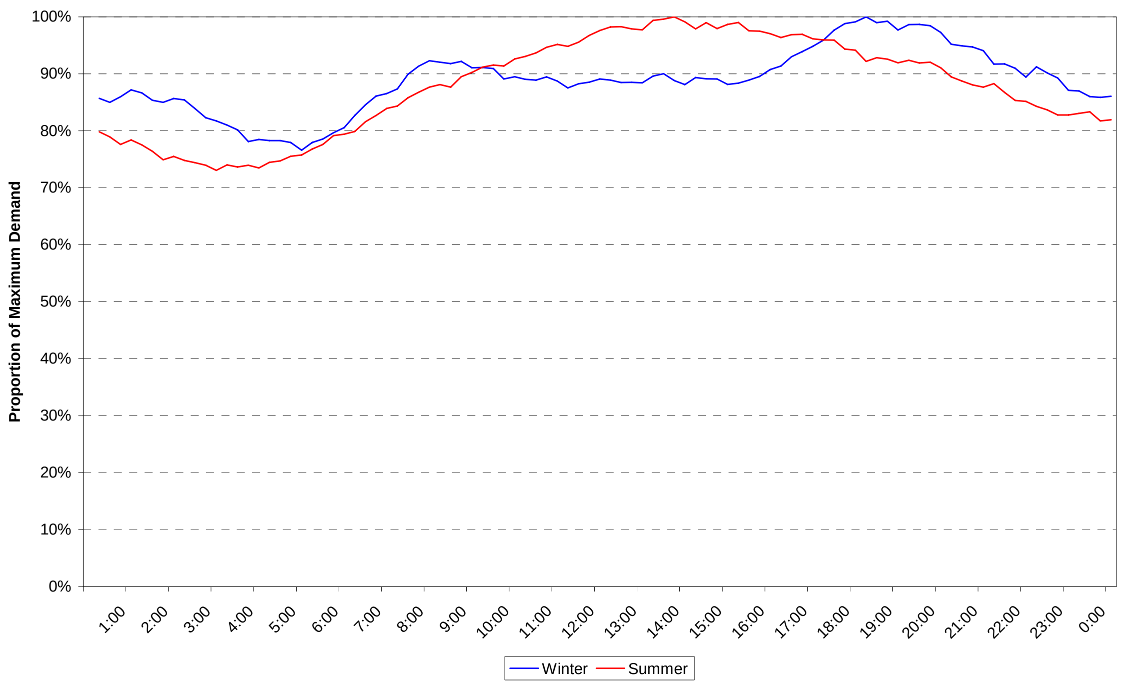
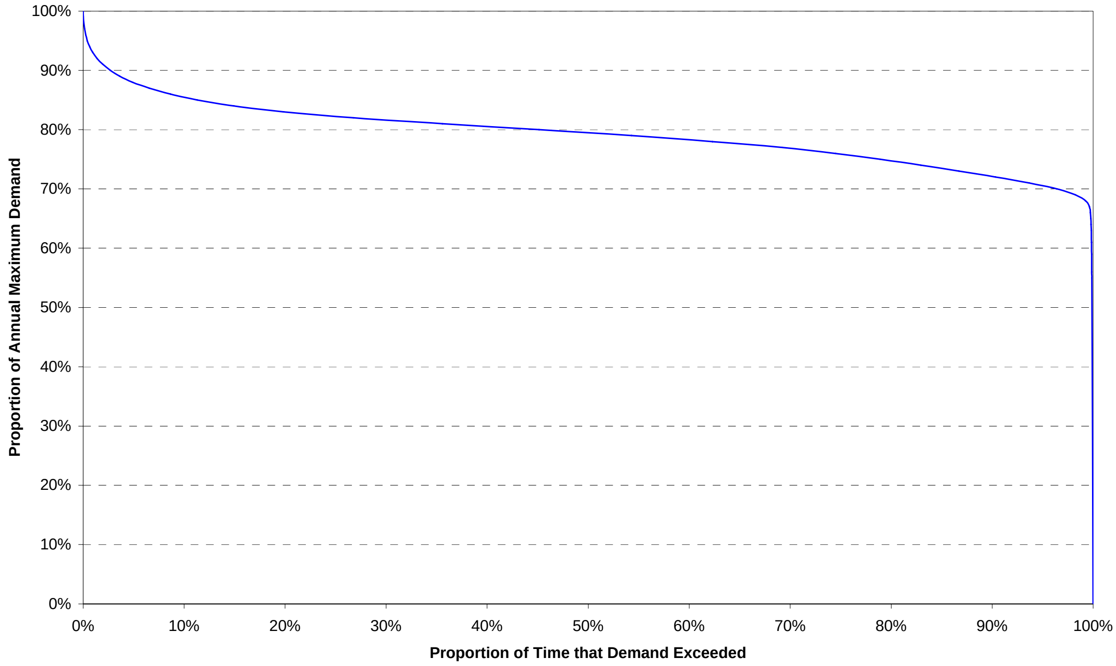


Diagram A1.4 shows the load duration curves (the proportion of time that particular demands, expressed as a proportion of the maximum demand for that year, are exceeded).

Diagram A1.4 Load Duration Curves for the Greater Newcastle Area



The load duration curve is relatively "flat" because the load in the area is dominated by the large aluminium smelter loads (of the order of 1,200 MW), which operate almost continuously. Consequently, periods of high customer demand for electricity are relatively frequent as shown in Table A1.1. It shows that actions to curtail demand to, for example, 90% of the expected maximum demand would typically have to be undertaken on 170 occasions each year and to operate for periods of typically up to 11 hours on each occasion.

Table A1.1 Typical Number and Duration of High Demand Events for the Greater Newcastle Area

Demand Threshold (Proportion of Maximum Demand)	Typical Total Duration of All Events Where the Threshold is Exceeded (hours p.a.)	Typical Maximum Duration of an Individual Event Where the Threshold is Exceeded (hours)	Typical Number of Events per Year Where the Threshold is Exceeded
95%	35	5	40
90%	250	11	170
85%	1,000	16	550

A1.4 Central Coast to Wollongong Area

This area includes the Central Coast area (south of Lake Macquarie), the greater Sydney area and the Wollongong area. Included in the load supplied at Wollongong is the south coast load (from Wollongong to the Moruya area).

In recent years the growth in summer maximum demand for electricity has exceeded that of winter maximum demands. The maximum demands in summer and winter are comparable.

Diagram A1.5 shows the maximum demands (averaged over a half hour period) for each day from 1 July 1996 to 19 September 2007. The average growth in summer maximum demand for electricity in the Central Coast to Wollongong area over this period has been approximately 4% p.a.

Diagram A1.5 Daily Maximum Demand for Electricity in the Central Coast to Wollongong Area

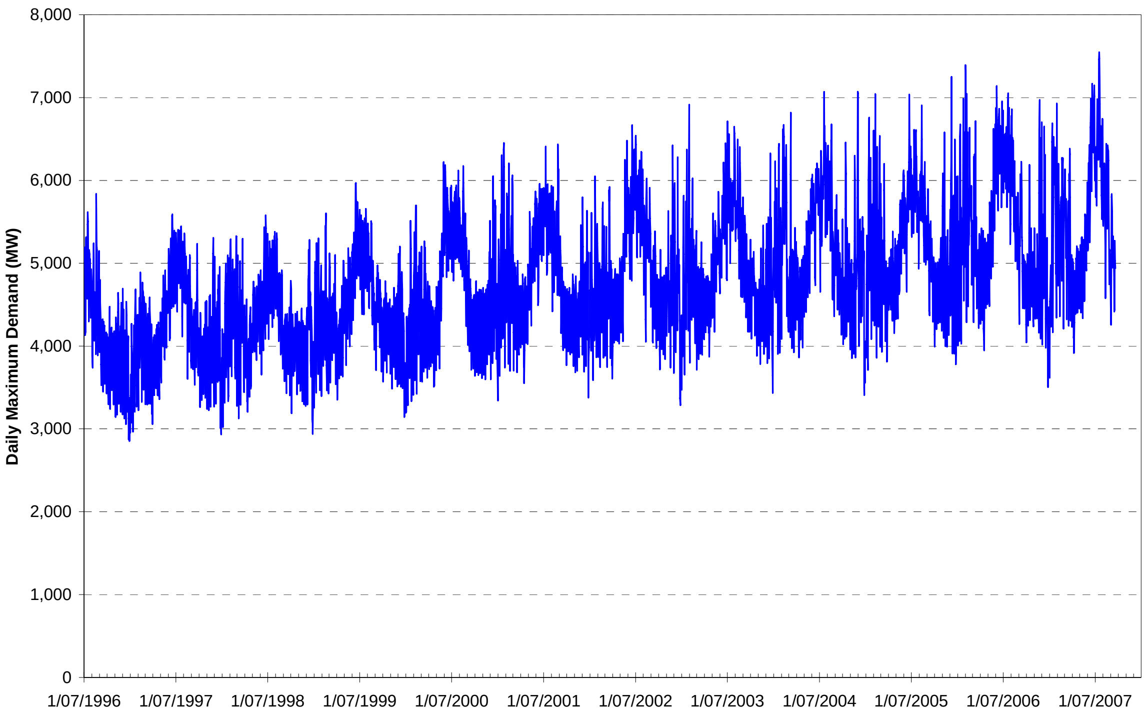


Diagram A1.6 shows typical profiles for the days of summer and winter maximum demands.

Diagram A1.6 Central Coast to Wollongong Load Profiles on Day of Maximum Demand

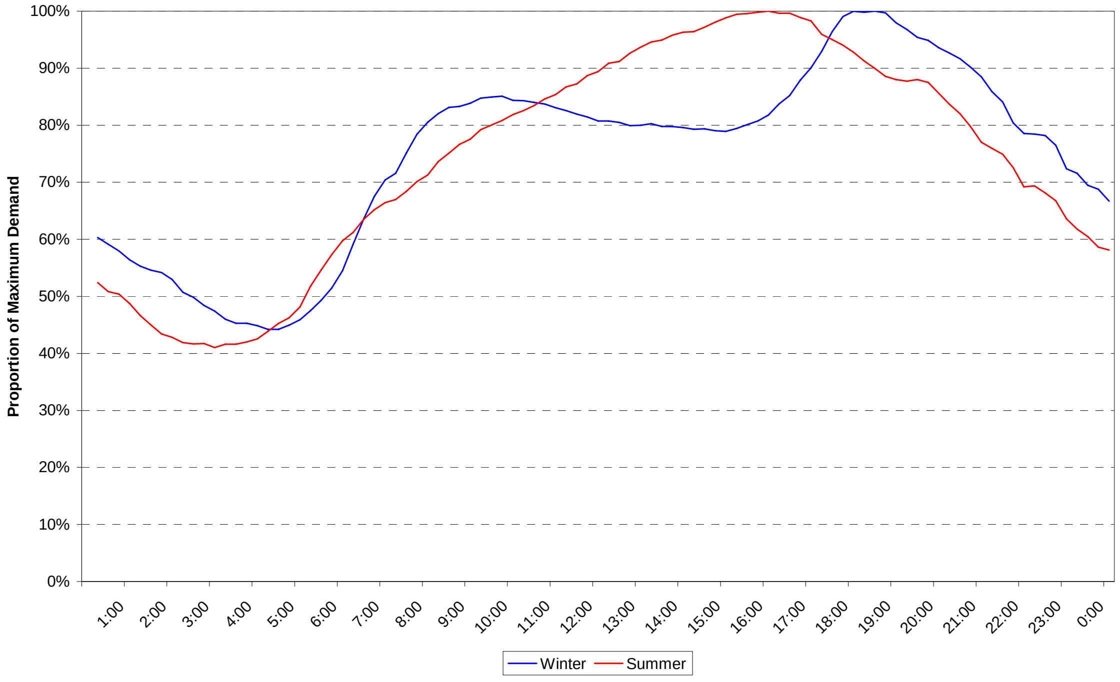
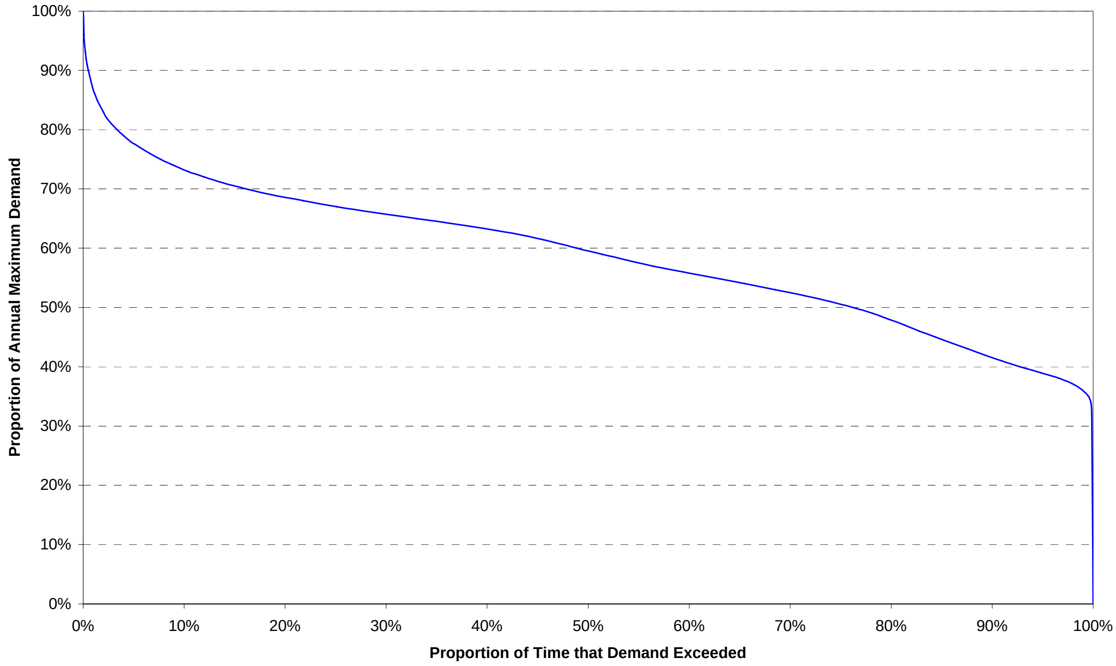


Diagram A1.7 shows the load duration (the proportion of time that particular demands, expressed as a proportion of the maximum demand for that year, are exceeded).

Diagram A1.7 Load Duration Curves for the Central Coast to Wollongong Area



Periods of high load are less frequent than for the greater Newcastle area, as shown in Table A1.2. It shows that actions to curtail demand to, for example, 95% of the expected maximum would typically have to be undertaken on 5 occasions each year and to operate for periods of typically up to 5 hours on each occasion.

Table A1.2 Typical Number and Maximum Duration of High Demand Events for the Central Coast to Wollongong Area

Demand Threshold (Proportion of Maximum Demand)	Typical Total Duration of All Events Where the Threshold is Exceeded (Hours p.a.)	Typical Maximum Duration of an Individual Event Where the Threshold is Exceeded (Hours)	Typical Number of Events per Year Where the Threshold is Exceeded
95%	10	5	5
90%	45	8	30
85%	120	10	60

A1.5 What Causes High Demand?

From a transmission network capability perspective, summer is the most critical time due to lower thermal ratings of equipment (under the prevailing higher ambient temperatures) and poorer power factors of customer demand (usually due to air conditioning) than at other times of the year. Increasing use of air conditioners in recent years has contributed to the growth in summer maximum demands throughout the State. It has also contributed to greater sensitivity of demand to temperature. Diagram A1.1 and Diagram A1.4 show, inter alia, the recent increase in the “volatility” of demand over summer for the greater Newcastle and Central Coast to Wollongong areas, respectively.

An inspection of the maximum demand data for the days of highest demand in recent summers shows that:

- The days of high demand occur more frequently in January and February.
- High demand typically occurs on working weekdays.

A1.6 The Demand Forecasts

The forecast summer 10% PoE maximum demands for the greater Newcastle area and the Central Coast to Wollongong area are shown in Table A1.3 and Table A1.4. Diagram A1.8 and Diagram A1.9 show recent actual maximum demands and the (diversified) forecast 10% PoE maximum demands.

The planning approach applied by TransGrid, including the rationale for using 10% PoE forecast demands is discussed in Appendix 2.

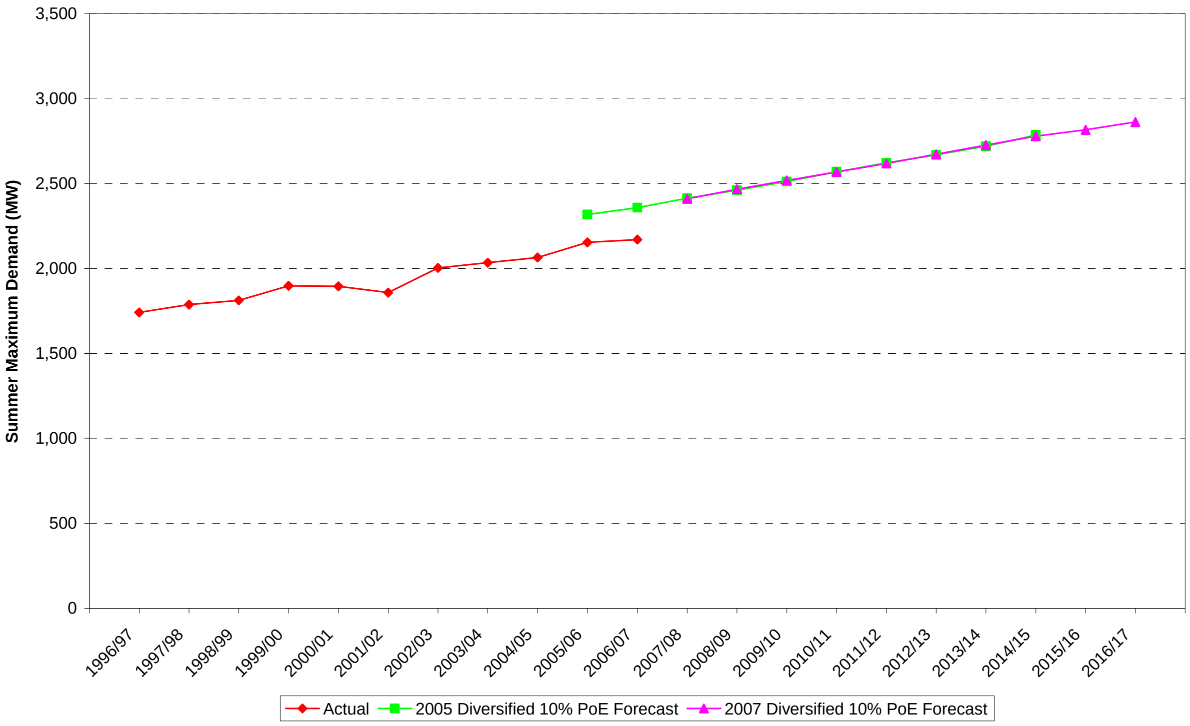
Table A1.3 Greater Newcastle Summer 10% PoE Maximum Demand Forecasts (MW)

Supply Point	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
Greater Newcastle	2,409	2,467	2,518	2,568	2,617	2,672	2,726	2,779	2,816	2,862

Table A1.4 Central Coast to Wollongong 10% PoE Summer Maximum Demand Forecasts (MW)

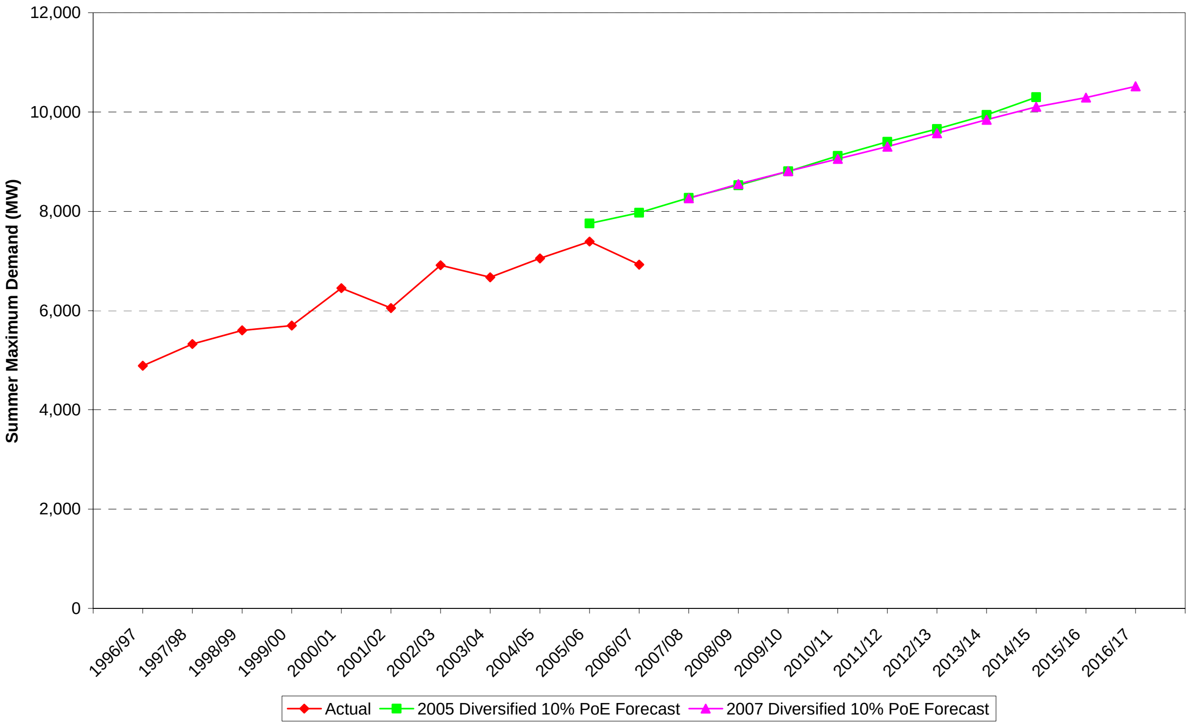
Supply Point	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
Central Coast	469	488	506	523	540	560	580	599	613	631
Greater Sydney	7,084	7,331	7,552	7,768	7,979	8,214	8,444	8,669	8,827	9,021
Wollongong	711	731	749	766	783	802	820	838	850	865
Total	8,264	8,550	8,807	9,057	9,302	9,576	9,844	10,106	10,291	10,517

Diagram A1.8 Greater Newcastle Actual and 10% PoE Forecast Maximum Demands



The forecast maximum 10% PoE demands for the greater Newcastle area are above the levels which would be derived by projecting historical maximum demands as they include recent increases in major industrial loads.

Diagram A1.9 Central Coast to Wollongong Actual and 10% PoE Forecast Maximum Demands



A1.7 Comparison of Demand Forecasts of different years

The studies undertaken at the time of the Application Notice used the main system forecast of loads at the 132 kV buses of the 330 kV substations. The main system forecast was derived by taking the state load forecast and assigning the individual 132 kV loads based on their historical proportions at the time of system peak load. These proportions came from peak load snapshots from the NEMMCO and TransGrid Energy Management Systems (i.e. SCADA measurements).

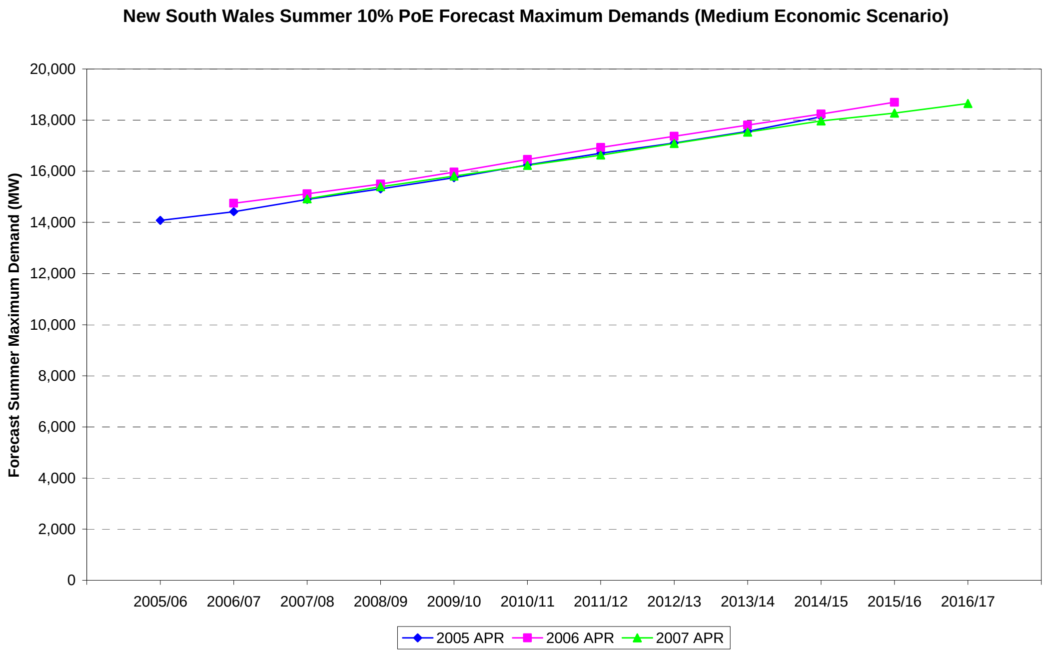
In particular the area 10% probability of exceedence (PoE) forecasts are developed from the State 10 % PoE forecast and measured loads at major substations on a day of (or near) 10% PoE demand. Essentially, the measured loads are scaled (where appropriate, as some loads such as major industries are relatively constant) to align with the forecast total State load for each year.

Thus the 10% PoE forecasts represent diversified demands at the time of the overall state maximum demand. Given that the State load is dominated by the Newcastle/ Sydney/ Wollongong load, this is also the time of Newcastle/Sydney/Wollongong maximum demand.

Diagram A1.10 shows the forecast NSW 10% PoE summer maximum demands published in the 2005, 2006 and 2007 Annual Planning Reviews (APRs). The 2007 forecast has been adjusted to exclude the Tweed Shire load (which was included in the NSW forecast for the first time in 2007 to reflect a regional boundary change).

The forecast used in the analysis reported in the Newcastle/ Sydney/ Wollongong Area Application Notice and Final Report was based on the NSW forecast published in the 2005 APR. Looking at the period of interest from 2009/10 the forecast in the 2006 APR is slightly above that in the 2005 APR, although the increase is only around half of one year's load growth, and therefore immaterial. The forecast in the 2007 APR (corrected for the Tweed Shire load) is very close to that in the 2005 APR.

Diagram A1.10 Comparison of 10% PoE Maximum Demands as forecast in 2005, 2006 and 2007



The latest demand forecasts for the Newcastle and Central Coast to Wollongong areas are very similar to those prepared in 2005 for the years of interest. Consequently, system studies carried out to determine the need for system augmentations carried out on the basis of the 2005 forecast are still valid and no new studies have been undertaken.

It should be noted that the need for the supply reinforcement is not very sensitive to the details of the power flow modelling given that the load is growing by the order of 300 MW per annum.

A2 Appendix 2 - The Criteria Used to Determine Transmission Network Capability

NOTE: The information contained in this Appendix is based on Section 2.4 of TransGrid's "Final Report, Proposed New Large Transmission Network Asset, Development of Supply to the Newcastle - Sydney - Wollongong Area, October 2006". This document can be found in Appendix 12 or on TransGrid's web site http://www.transgrid.com.au/trim/trim224993.pdf

Under NSW legislation TransGrid has responsibilities that include planning for future NSW transmission needs, including interconnection with other networks.

In addition, as a Transmission Network Service Provider (TNSP) TransGrid is obliged to meet the requirements of Schedule 5.1 of the Rules. In particular, TransGrid is obliged to meet the requirements of clause S5.1.2.1 in Schedule 5.1:

> *"Network Service Providers* must plan, design, maintain and operate their *transmission networks* to allow the transfer of power from *generating units* to *Customers* with all *facilities* or equipment associated with the *power system* in service and may be required by a *Registered Participant* under a *connection agreement* to continue to allow the transfer of power with certain facilities or *plant* associated with the *power system* out of service, whether or not accompanied by the occurrence of certain faults (called "*credible contingency events*").

TransGrid's planning obligations are also interlinked with the licence obligations imposed on all Distribution Network Service Providers (DNSP) in NSW. TransGrid plans its transmission network to enable these licence requirements to be met.

Jurisdictional Planning Requirements

In addition to meeting requirements imposed by the NER, Connection Agreements, environmental legislation and other statutory instruments, TransGrid is required by the NSW jurisdiction to describe in the five year Network Management Plan (lodged with the Department of Water and Energy), the transmission planning requirements, so as to meet the statutory obligations contained in the Electricity Supply Regulation (Safety and Management) 2002. In this document TransGrid describes its planning and development of its transmission network on an "N-1" basis, except in the case of the Sydney CBD where a "modified N-2" reliability standard is required. That is, unless specifically agreed otherwise by TransGrid and the licensed distribution network owner or major directly connected end-use customer, there will be no inadvertent loss of load (other than load which is interruptible or dispatchable) following an outage of a single circuit (a line or a cable) or transformer, during periods of forecast high load.

In fulfilling this obligation, TransGrid must recognise specific customer requirements as well as NEMMCO's role as system operator for the NEM. To accommodate this, the standard "N-1" approach can be modified in the following circumstances:

- Where agreed between TransGrid and a distribution network owner or major directly connected end-use customer, agreed levels of supply interruption can be accepted for particular single outages, before augmentation of the network is undertaken (for example the situation with radial supplies).

- Where requested by a distribution network owner or major directly connected end-use customer and agreed with TransGrid there will be no inadvertent loss of load (other than load which is interruptible or dispatchable) following an outage of a section of busbar or coincident outages of agreed combinations of two circuits, two transformers or a circuit and a transformer (for example supply to the inner metropolitan/CBD area).

- The main transmission network, which is operated by NEMMCO, should have sufficient capacity to accommodate NEMMCO's operating practices without inadvertent loss of load (other than load which is interruptible or dispatchable) or uneconomic constraints on the energy market. At present NEMMCO's operational practices include the re-dispatch of generation and ancillary services following a first contingency, such that within 30 minutes the system will again be "secure" in anticipation of the next critical credible contingency.

Hence, in assessing the capability of the NSW core network to supply the forecast customer demands, TransGrid applies an "N-1" criterion such that[8]:

1. The power system is able to be operated so that it is in a secure state in anticipation of a credible contingency; and

2. The power system is able to be restored to a secure state within 30 minutes of a credible contingency occurring, in anticipation of a second credible contingency.

Accordingly TransGrid plans the transmission network to avoid the need for pre-emptive customer load shedding for credible circumstances. Pre-emptive load shedding would entail interrupting supply to customers prior to a critical outage occurring, to ensure that power system security could be maintained if that outage were to occur. That is, load interruptions would be required, with the transmission network in its normal state, to cater for critical outages that may not occur.

Requirements 1 and 2 are typically met by the scheduling (or rescheduling) of generation. Under normal system conditions the dispatch of generation is primarily governed by the market behaviour of generators and it is possible to have a wide range of different generation patterns within NSW and in other states, influencing the power flow over the interconnectors with NSW.

Accordingly, TransGrid's analysis of the capability of the NSW core network to adequately deliver power to the Newcastle – Sydney – Wollongong load area considers:

- NEMMCO's power system security obligations;
- Single credible contingencies;
- Days of high summer demand for electricity, including using 10% probability of exceedence (PoE) forecast demands; and
- A range of generation patterns that could reasonably be expected to occur.

Over the last ten years, the reliability of the core NSW network has met the planning criteria described above.

[8] Further details of TransGrid's planning criteria may be found in TransGrid's 2007 Annual Planning Report

A3 Appendix 3 - Transmission Network Limitations

NOTE: The information contained in this Appendix is based on Section 2.5 of TransGrid's "Final Report, Proposed New Large Transmission Network Asset, Development of Supply to the Newcastle - Sydney - Wollongong Area, October 2006". This document can be found in Appendix 12 or on TransGrid's web site http://www.transgrid.com.au/trim/trim224993.pdf

A3.1 Introduction

TransGrid carried out analysis of this system in early 2006 as part of the input into the regulatory test. This analysis was based on TransGrid's 2005 forecast, NEMMCO's 2005 SOO and other system conditions at that time. There is no requirement under Pass-Through Rules for TransGrid to revisit this analysis. However, as a responsible TNSP TransGrid has considered factors that may have changed since the application of the regulatory test and considered whether these are material. Factors that may have changed since early 2006 that would impact on the outcome of those studies are:

- Changes to the network;
- Change in load forecast for the study area; and
- Change in generation in the study area.

There have been no changes to the network. As noted in Section A1.7 of Appendix 1, the latest load forecast for the study area has not changed significantly from the 2005 forecast for the years of interest. However, expected generation in the study area has changed. TRUenergy's Tallawarra Gas Turbine Project and Delta Electricity's Colongra Gas Turbine Project are now more advanced. In TransGrid's 2006 studies it was assumed that this plant would not necessarily be available. It is still uncertain whether this plant will be in service in time to alleviate constraints, even partially, over the summer 2008/09 period.

The option that satisfied the regulatory test in 2006 (NERA Option B - see Appendix 6) included the use of network support in the summer of 2008/09 instead of network augmentation. TransGrid called for offers of network support and have received several offers from the market. If by summer 2008/09 Tallawarra is participating in the NEM the amount of network support required in the preferred option will be reduced. Offers of network support and their impact on the staging of the Western 500kV Conversion are discussed further in Schedule 3. Information contained in this schedule is to be treated as "Commercial-in-Confidence".

Colongra Gas Turbine plant capacity could have an impact on the studies. This plant, which has a capacity of 680MW, was not committed at the time of the studies. However, TransGrid understands that there is a high likelihood that the existing Munmorah units may be decommissioned. The resulting net capacity increase is too small to have a significant impact.

As shown above, changes to the input assumptions to the 2006 studies will not have a material impact on the findings of those studies and consequently the need for the proposed works. Consequently, TransGrid has not carried out new studies and the 2006 studies are still valid.

A3.2 Limitations

The transmission network supplying the Newcastle – Sydney – Wollongong area faces two main emerging limitations:

1. Overloading of one of the two 330kV transmission lines between the Hunter Valley power stations (Liddell and Bayswater) and the Newcastle area. This could occur following an outage of the other line; and

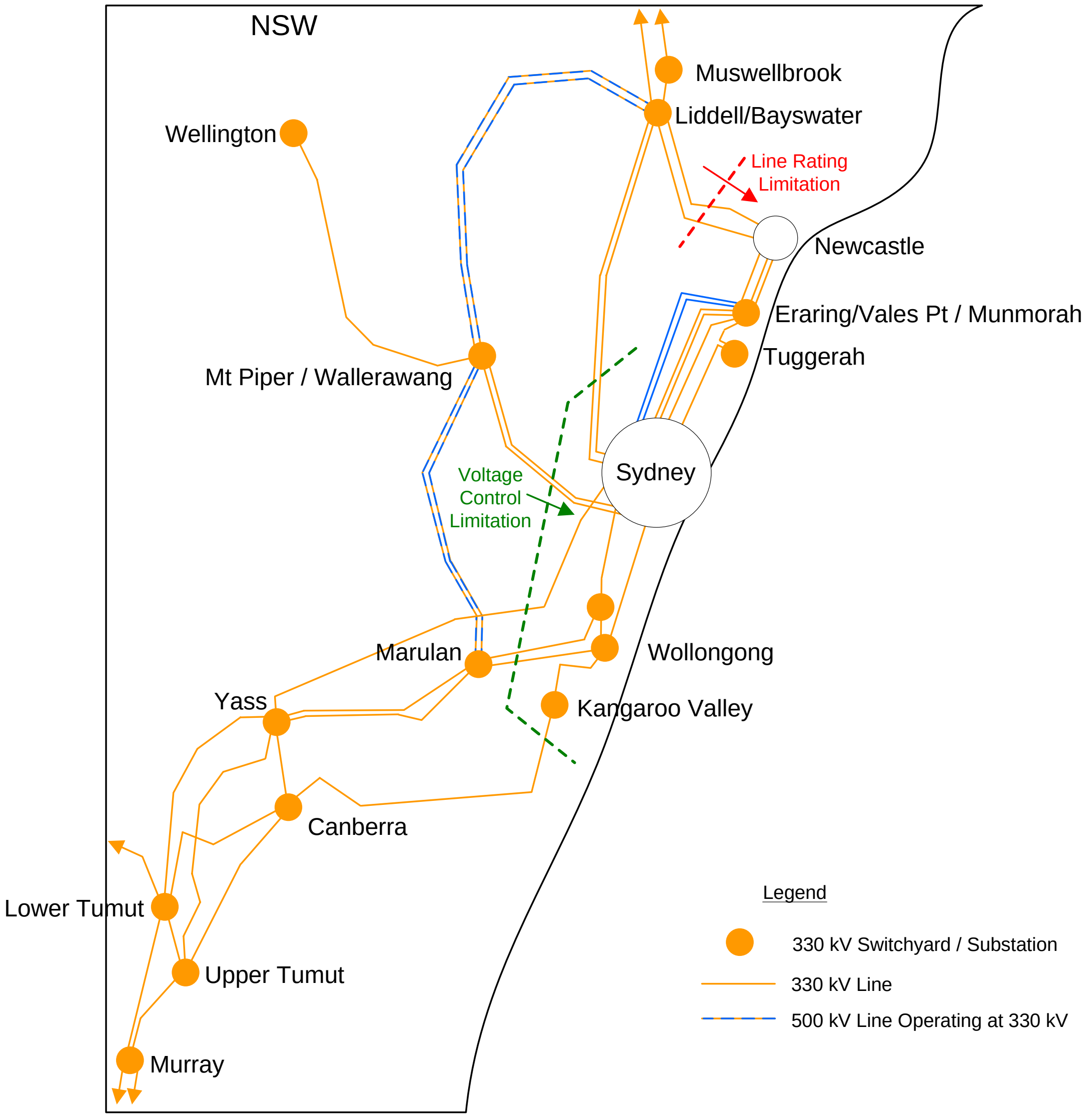
2. Inadequate control of voltage levels in the Sydney area 330kV network. This could occur following an outage of one of a number of 330kV circuits, in particular either of the circuits between Bayswater and Western Sydney (either of the Bayswater – Regentville/Sydney West circuits).

These limitations are exacerbated by high power transfers from the north of the State and the south of the State to the major load centres. They are described in more detail in the following sections.

With the growing State demand for electricity and increasing dependence on existing generation sources[9] it is expected that these limitations will become a critical reliability issue for supply to this area from the summer of 2008/09 onwards under the medium economic growth load forecast[10]. The limitation is expected to arise in summer 2007/08 under the high economic growth forecast and in 2009/10 under a low economic growth forecast.

These transmission network limitations are shown in Diagram A3.1 and described in detail in Sections A3.2.1 and A3.2.2.

Diagram A3.1 Transmission Network Limitations – Summary



Options to relieve these limitations must be consistent with sound longer term development strategies and:

- Increase transmission capacity across the constrained parts of the network; and/or

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[9] As the margin between the total generation capacity and the load level diminishes, the scope to re-dispatch generation to manage network limitations also reduces.
[10] Reference should be made to TransGrid's Revenue Reset application to the ACCC 2004

- Alter power flows to reduce flows across the constrained parts of the network and increase flows elsewhere; and/or
- Reduce the effective load on the network in the Newcastle – Sydney – Wollongong area.

The proposed development forms part of the “500 kV ring” which is expected to be necessary to meet the longer term requirements of electricity within the State. It alters power flows to reduce the loading on the 330kV lines between the Hunter Valley power stations and the Newcastle area. It supports voltages in the Newcastle – Sydney – Wollongong area by reducing reactive losses, providing additional “line charging” and increasing access to the reactive power capability of power stations in the Hunter Valley and in the Lithgow area.

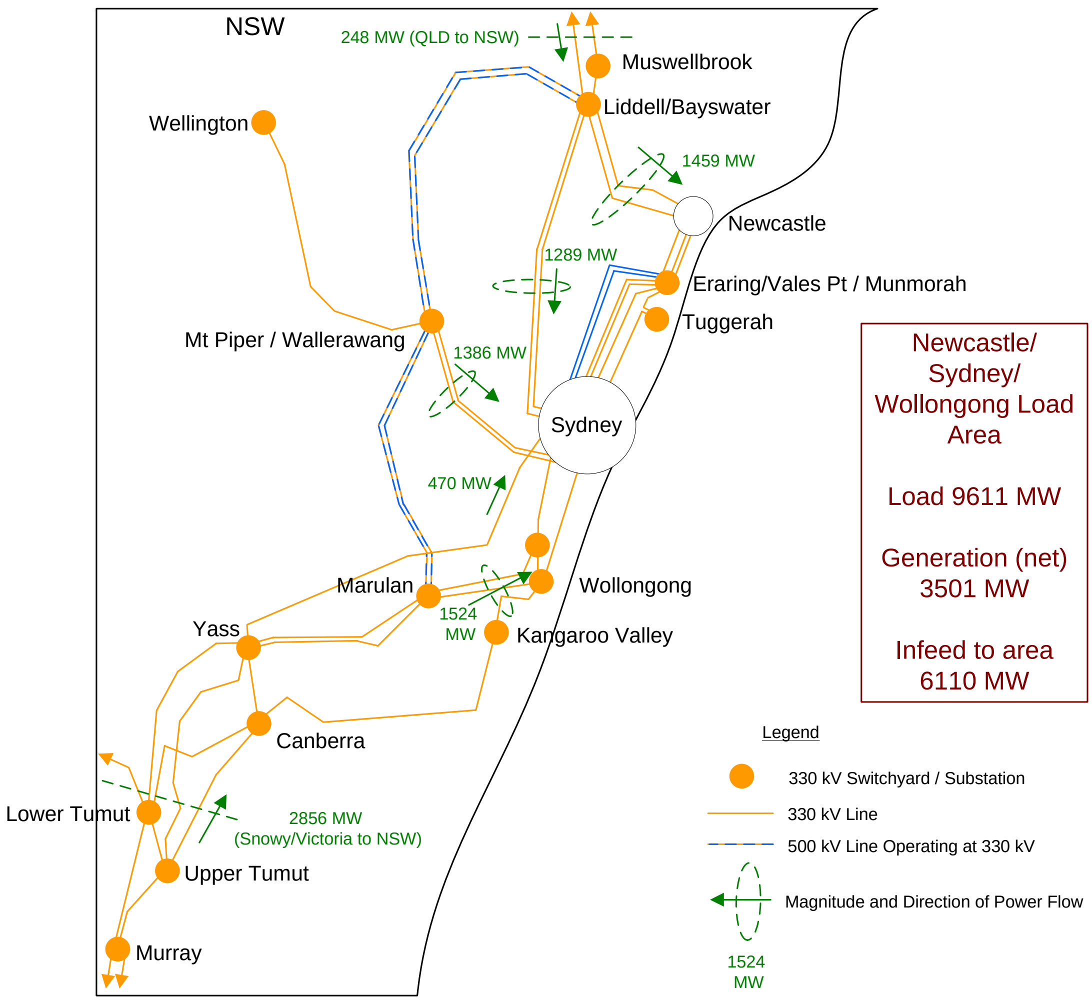
A3.2.1 Hunter Valley to Newcastle Line Rating Limitation

The supply capability to the load area, governed by the Hunter Valley – Newcastle line rating limitation, is a function of the generation levels at the NSW power stations and the level of supply from the south and from Queensland. TransGrid believes that, without corrective action, it will not be possible to manage this limitation from summer 2008/09.

The patterns of power flow in the NSW core network are determined by the load levels in the major load areas and the distribution of generation throughout the State, in conjunction with power flow over the interconnectors.

In order to illustrate how power is distributed along the various transmission paths, Diagram A3.2 shows the pattern of power flows on the major transmission paths supplying the Newcastle – Sydney - Wollongong load area at a time of a high NSW demand on a hot day in early February 2006 (the values shown are indicative for illustration purposes and have been taken from a snapshot of the power system conditions at one particular instant of time).

Diagram A3.2 Illustrative Power Flows at a time of High Summer Demand



Overall NEM Demand about 30,000 MW

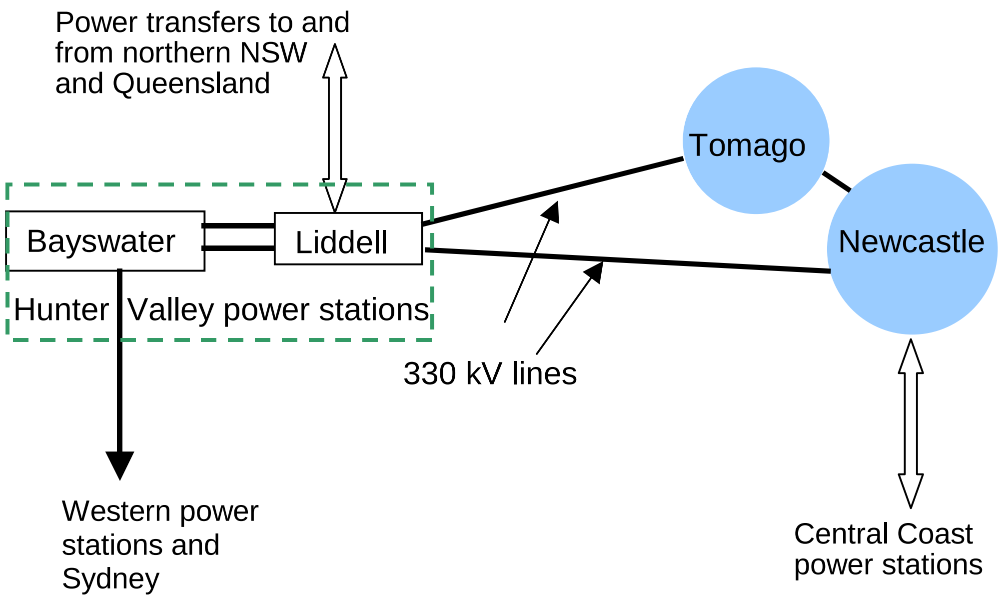
At the time that this pattern was observed the load in the Newcastle – Sydney – Wollongong load area was about 9,600 MW. The Central Coast power stations within the Newcastle – Sydney – Wollongong area contributed about 3,500 MW resulting in a net in-feed to the load area of about 6,100 MW. The net in-feed to the area was supplied by the other power stations throughout the interconnected southeast Australian system, outside the Newcastle – Sydney – Wollongong load area.

The supply situation at this time was characterised by relatively low import to NSW from Queensland and high import to NSW from Snowy and Victoria.

The pattern of power flows was governed by the generation distribution. Under a different generation distribution there could have been higher import from Queensland and higher output from the Hunter Valley power stations which would result in higher power flows from the Hunter Valley to the Newcastle – Sydney – Wollongong load area. Under another different generation distribution there could have been higher power import from the south which would tend to increase the loading in the transmission links between the southern system and Sydney.

As shown in Diagram A3.3 there are two 330kV transmission lines between Liddell Power Station and the Tomago / Newcastle area. A number of transmission lines then connect Newcastle to the Central Coast power stations.

Diagram A3.3 The Hunter Valley to Newcastle Network



The present output capability of the power stations and import capability from Queensland is shown in Table A3.1[11]:

Table A3.1 Present Hunter Valley Power Station Capability & Import Capability from Queensland (Summer Conditions)

Input to System	Capability (MW)
Bayswater	2,720
Liddell	2,080[12]
Redbank (near Muswellbrook)	148
Total Hunter Valley generation	4,948
Import from Queensland via QNI	Up to 1,078 MW (the capability is variable depending on system conditions)[13]
Import from Queensland via Directlink	Approximately 196 MW[14]
Total of generation and import	Approximately 6,200

Hence the generation in the Hunter Valley area together with import from Queensland can potentially supply a large part of the NSW load.

There is a relatively high power flow from Liddell to the Tomago / Newcastle area at times of high generation in the Hunter Valley and high import of power from Queensland.

[11] The power station MW capability is as documented in NEMMCO's Statement of Opportunities (SOO) 2006. Power station output may vary above these levels in practice.
[12] The 2006 SOO quotes the Liddell generation capability as 2070 in summer 2006/7, rising to 2080 MW by summer 2008/09.
[13] The capability for import to NSW via QNI is dependent on a number of system limitations. Damping presently sets a limit to the interconnector capability of a maximum of 1,078 MW. System conditions can arise where the transient stability limits or line thermal rating limits become dominant and the import capability may be lower than 1,078 MW.
[14] Directlink is connected to the Gold Coast system in Queensland. The capability for power transfer over Directlink to NSW is determined by the level of load on the Gold Coast. Under high load conditions in the Gold Coast area the capability may fall below 196 MW.

This power flow is also affected by the load level in the Tomago / Newcastle area and the level of generation at the Central Coast power stations. As the load level in the Newcastle area is increased the power flow between the Hunter Valley and the Newcastle area tends to increase. Similarly as the generation in the Central Coast is reduced there tends to be an increase in power flow between the Hunter Valley and the coast.

An outage of either of the two 330kV transmission lines between Liddell and the Tomago / Newcastle area can lead to a high loading on the other line. The two 330kV lines have been designed for high temperature operation and uprating them is not considered to be practicable. The impact of these transmission line ratings is an overall limitation on the combined level of generation in the Hunter Valley and import of power from Queensland.

To date, this limitation has been managed by constraining generation at the Hunter Valley power stations and/or reducing imports from Queensland over QNI, according to NEMMCO's market operation practices.

This line rating limitation imposes a constraint on market operation at infrequent times at present. The constraint has arisen at times when there has been high import of power from Queensland, relatively high Hunter Valley generation (the majority of the eight Bayswater and Liddell generators operating) and reduced Central Coast generation. The limitation will be exacerbated in the future by higher Hunter Valley generation (should all eight Bayswater/Liddell units operate frequently to meet the State load requirements), increased incidence of high levels of import from Queensland and increasing Tomago / Newcastle area loads.

The line rating limitation is partly governed by the level of Central Coast generation. The Central Coast generation is shown in Table A3.2[15]:

Table A3.2 Central Coast Generation Capability

Power Station	Generating Capability (MW)
Eraring	2,640
Vales Pt	1,320
Munmorah	600
Total of generation	Approximately 4,560

It should be noted that this capability may not be always available in summer. The Vales Point power station output may be limited to below 1,320 MW due to cooling water considerations in summer[16]. Munmorah is the oldest of the power stations in the area and has the lowest capacity factor of the stations.

Table A3.3 provides an indication of the impact on the supply capability to the Newcastle – Sydney – Wollongong area due to the limited thermal rating of the Hunter Valley – Newcastle network. This table has been derived under the following assumptions:

- The NSW load has been set at the 10% PoE forecast level (medium economic growth scenario);
- All NSW thermal generation is assumed to operate its maximum level, except as shown in Table A3.3: and
- Shoalhaven generation is assumed to not be in service.

The total supply to NSW is made up of NSW generation, Snowy generation and import from Queensland and Victoria. In order to illustrate the supply capability to the Newcastle – Sydney – Wollongong load area in Table A3.3, the NSW thermal generation has been assumed to be at its maximum. Various levels of Snowy and import from Victoria have then been assumed, constituting a

[15] NEMMCO SOO 2006
[16] Reference should be made to NEMMCO's SOO 2006

certain level of import from the south. This import was varied between 2,800 MW and 3,200 MW for the purpose of illustration. As the import from the south was varied the import from Queensland was then adjusted to match the overall demand in the State.

Because the thermal rating limitations between the Hunter Valley and Newcastle are very dependent on the level of generation in the Central Coast (which is within the load area), various levels of Central Coast generation were then analysed. Generation was withdrawn in the Central Coast in two steps of 300 MW. Hence Table A3.3 shows the margin of supply capability above the area load as the level of generation in the area is varied, with the sharing of supply to NSW then balanced between import from the south and import from Queensland.

When the transmission capability exceeds the load in the area in Table A3.3 the margin of supply is positive. When the transmission capability falls below the area load the margin is negative.

Table A3.3 Margin of supply capability over the load level in the Newcastle – Sydney – Wollongong area

	Difference between the supply capability and load (MW)					
	2007/08			2008/09		
Import from south	Central Coast Generation 600 MW below maximum	Central Coast Generation 300 MW below maximum	Maximum Central Coast Generation (Note 1)	Central Coast Generation 600 MW below maximum	Central Coast Generation 300 MW below maximum	Maximum Central Coast Generation (Note 1)
2800	-265	74	413	-492	-153	186
2900	-183	156	495	-410	-71	268
3000	-113	216	555	-340	-11	328
3100	-52	287	626	-279	60	399
3200	9	348	687	-218	121	460

Note 1: The maximum Central Coast generation is approximately 4,560 MW as shown in Table A3.2.

The excess capability for supply to the area is shown graphically in Diagram A3.4 and Diagram A3.5, for summer 2007/08 and summer 2008/09, respectively.

Diagram A3.4 Excess Capability for Summer 2007/08

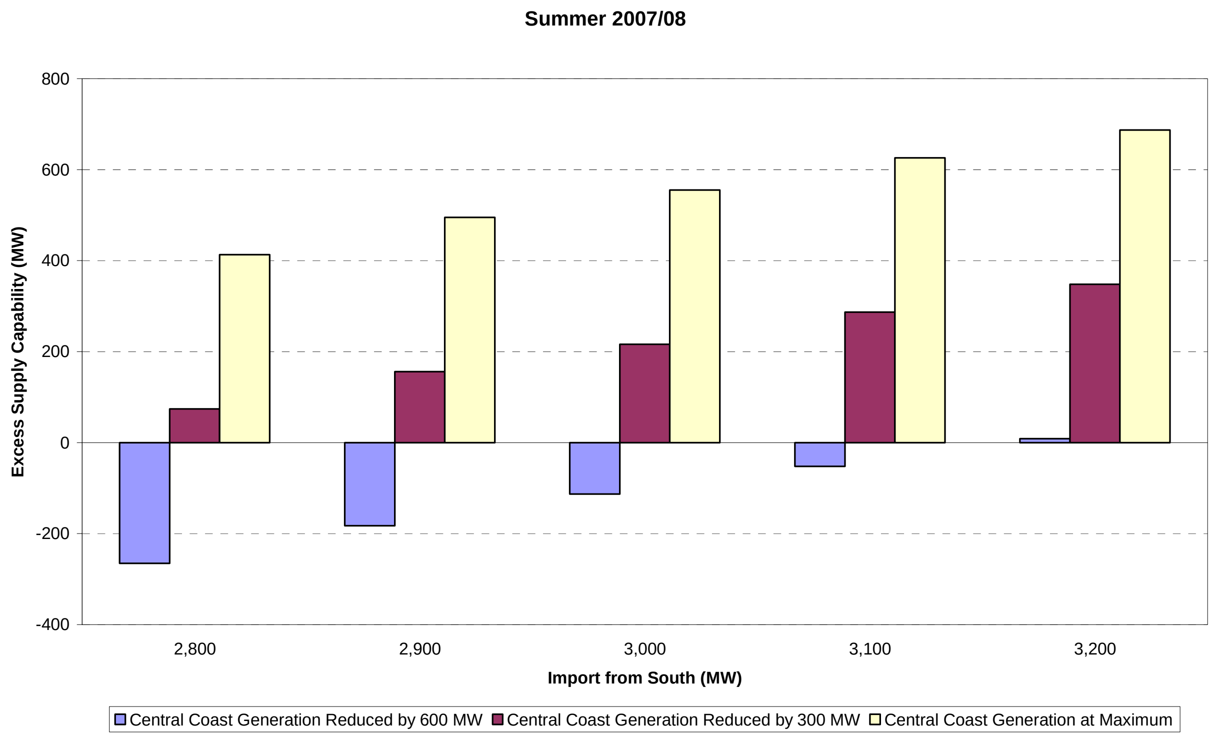
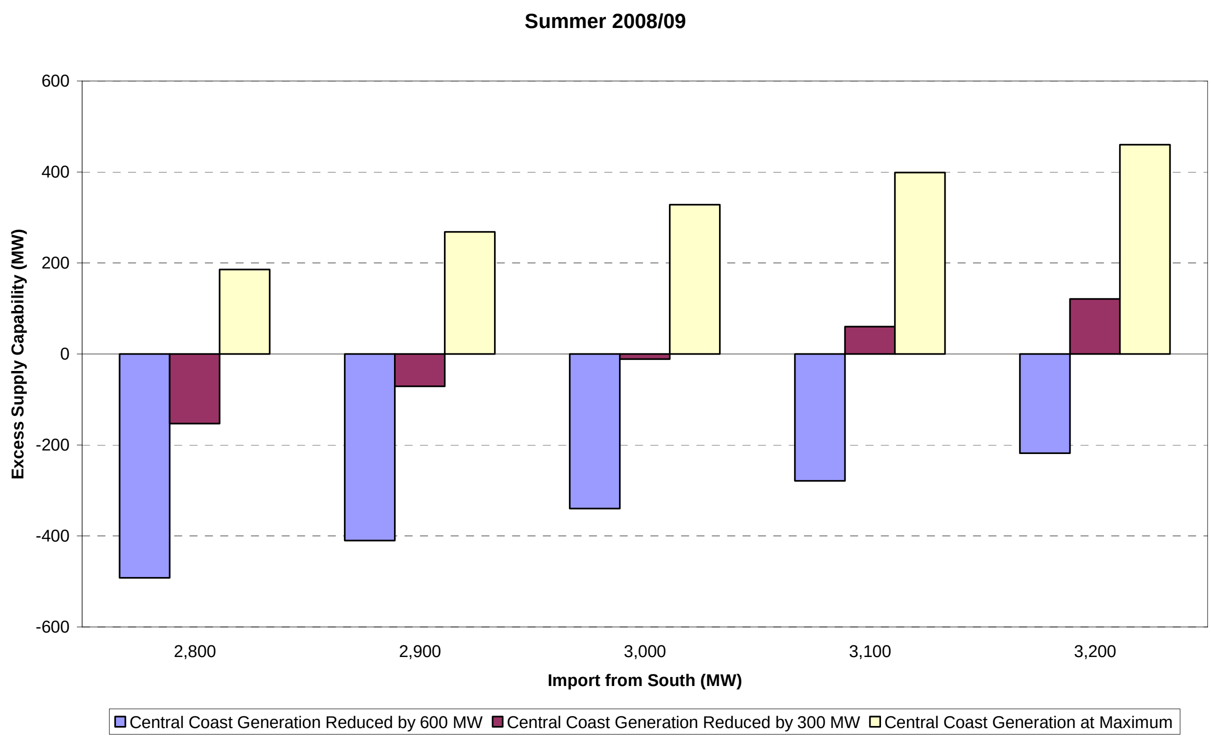


Diagram A3.5 Excess Capability for Summer 2008/09



For example in summer 2008/09 if the import from the south was set at 3,000 MW the supply capability to the Newcastle – Sydney – Wollongong area would exceed the actual load by 328 MW if the Central Coast generators operated at their maximum output. If the Central Coast generation was reduced by 300 MW there would be a shortfall in supply to the area of 11 MW and if the Central Coast generation was reduced by a further 300 MW (i.e. a reduction of 600 MW in total) there would be a shortfall in supply capability of 340 MW.

The limitation that would need to be placed on the supply to the Newcastle – Sydney – Wollongong area, to manage the loading on the Hunter Valley to Newcastle transmission lines, is directly related to the capability to generate power in the Hunter Valley and to import power from Queensland. Limiting these sources would also affect the ability to supply the overall NSW load.

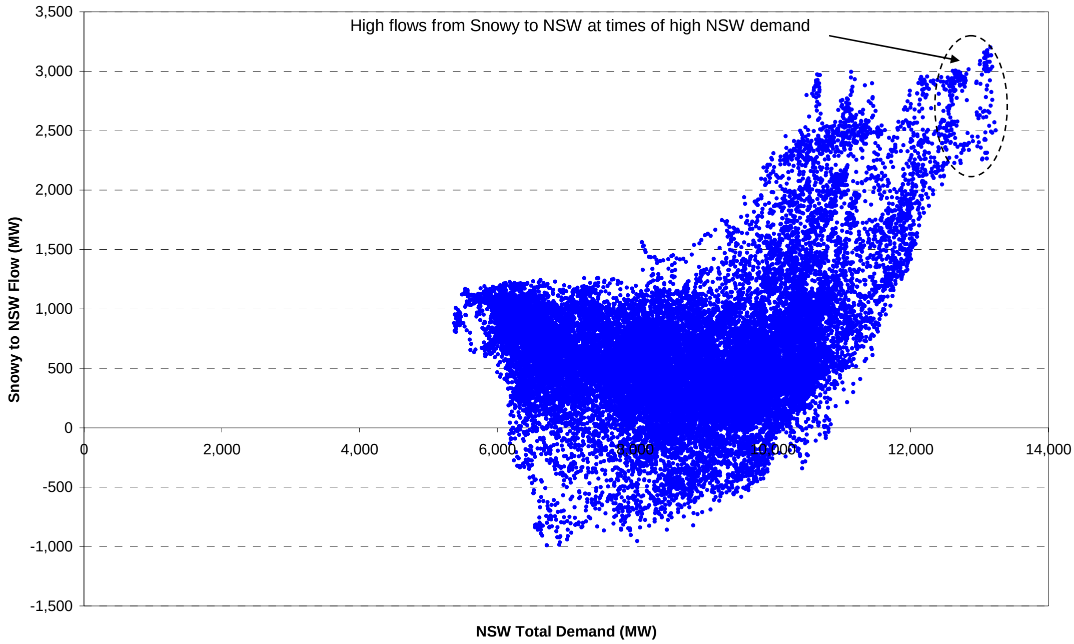
A shortfall in supply capability implies that the load could not be supplied and the load in the Newcastle – Sydney – Wollongong area would need to be reduced to enable the power system to operate securely.

The supply capability to the area is clearly a function of the generation levels at the NSW power stations and the availability of supply from the south and from Queensland.

The present import capability from the south is variable depending on system conditions but can typically be about 3,200 MW on a summer day. This actual import from the south varies up to this limit depending on generation dispatch within the market.

Diagram A3.6 shows the southern import level versus the NSW demand during the past summer. Import from the south varied up to about 3,200 MW but import at such high levels was relatively rare. At times of high NSW demand the import from the south has varied from about 2,300 MW to about 3,200 MW.

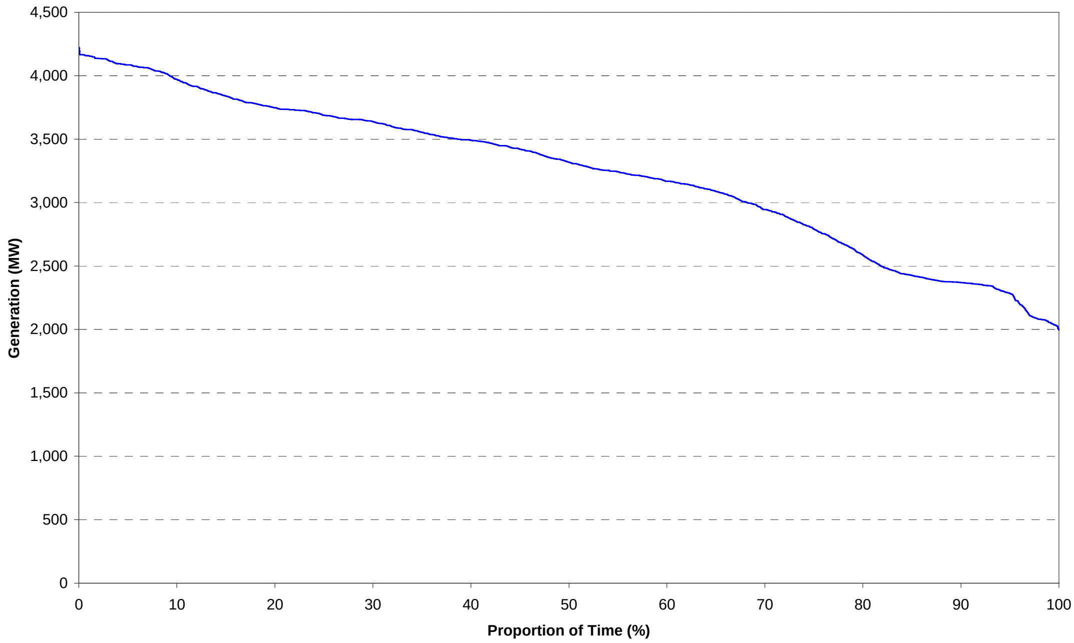
Diagram A3.6 Southern Import and NSW Demand



As an indication of recent generation patterns, the output of in the Hunter Valley, Central Coast and Western power stations over the past summer is shown in the following three diagrams. These diagrams are in the form of duration curves (i.e. cumulative frequency graphs - the output exceeds the level shown for the duration shown). Information of this type has been used in developing the generation patterns used in the planning analysis.

The total output of the Hunter Valley power stations is shown in Diagram A3.7. The maximum output recorded was below the maximum of 4,948 MW (refer to Table A3.1). It is expected that the maximum output will be approached more often in the future if Macquarie Generation operates all of the Bayswater and Liddell units in response to the tightening supply / demand balance in NSW.

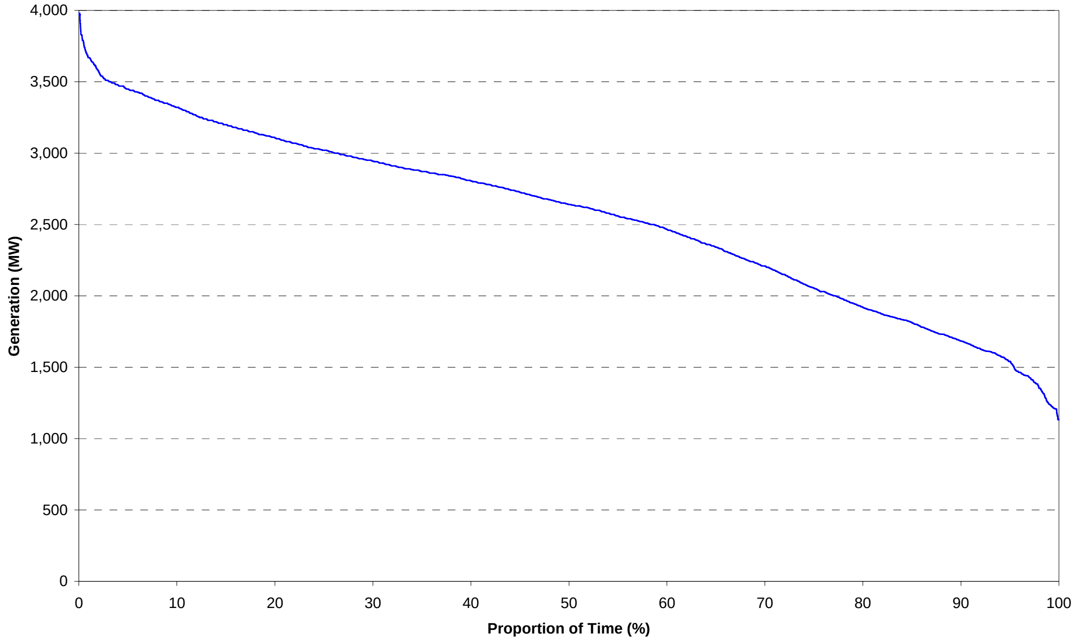
Diagram A3.7 Hunter Valley Power Station Output



The total output of the Central Coast power stations is shown in Diagram A3.8. The maximum output approached about 4,000 MW, well below the maximum of 4,560 MW shown in Table 3.2. The high levels of generation were also of a relatively short total duration.

It should also be noted that the Vales Point power station output may be limited below its maximum due to cooling water considerations in summer.

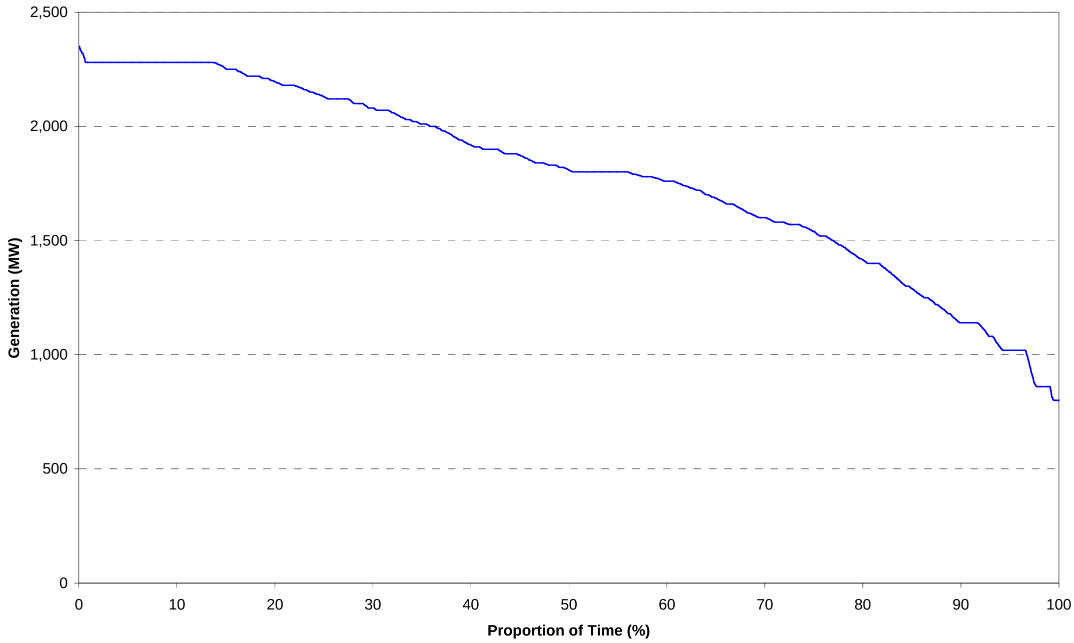
Diagram A3.8 Central Coast Power Station Output



The total output of the western power stations (Mt Piper and Wallerawang) is shown in Diagram A3.9. The maximum output approached the total capability of 2,400 MW[17]. High levels of output occurred over a relatively long total duration.

[17] 2006 SOO

Diagram A3.9   Western Power Station Output



In assessing the capability of the NSW core network to supply the Newcastle – Sydney – Wollongong area TransGrid must take into account the potential generation patterns throughout the State. Table A3.3 shows potential capability shortfalls in summer 2007/08 when the Central Coast generation is about 600 MW below its maximum. Otherwise in summer 2007/08 there is expected to be a margin in capability above the load at reasonably high levels of import from the south.

In summer 2007/08 it is however possible that Central Coast generation will need to be constrained to operate at high levels to manage the line rating limitation.

By summer 2008/09, in order to manage the supply limitation and to maintain the Hunter Valley – Newcastle lines within their capability, the Central Coast generation would need to be operated close to maximum output, even with high levels of import from the south. In this summer if the Central Coast generation was about 300 MW below its maximum output it would be necessary to import above 3,000 MW from the south to meet the full load in the Newcastle – Sydney – Wollongong area. The potential shortfall increases if either the output of the Central Coast generation is reduced or the import from the south is reduced.

TransGrid considers the planning criteria for supply to the Newcastle – Sydney – Wollongong load area would not be able to be met from summer 2008/09. TransGrid considers that it would not be prudent to rely on extreme generation patterns and the availability of every Central Coast generator to avoid a supply capability shortfall and that there would be an unacceptable risk to the supply to the Newcastle – Sydney – Wollongong area.

In the absence of additional transmission capability between the generation outside of the Newcastle – Sydney – Wollongong area or suitably located generation developments and/or demand reductions within the area, TransGrid believes that it will not be possible to adequately manage this limitation to the Newcastle – Sydney – Wollongong area and the overall NSW supply from summer 2008/09, over a reasonable range of generation dispatch conditions.

It should be noted that the potential shortfall in supply capability to the Newcastle – Sydney – Wollongong area would increase in future summers in accordance with the load growth in the area.

The limitation is expected to arise in summer 2007/08 under the high economic growth forecast and in 2009/10 under a low economic growth forecast.

Demand Side Remedial Options

One option to manage this limitation is to reduce customer demand in the Newcastle – Sydney – Wollongong area (or alternatively to supply some of the load from new generation in the area) in anticipation of an outage of one of the two critical transmission lines from the Hunter Valley.

Another option would be to rapidly reduce the local customer demand following an outage of one of the critical transmission lines. This may take the form of rapid and effectively unannounced load shedding.

It is anticipated that the load shedding controls would be automatic and would be armed at times when the 330kV transmission lines would be potentially overloaded should an outage of one of them occur. As these 330kV transmission lines are very reliable, it is expected that the load shedding would have a low probability of being required. Once shed, the load would need to remain off until the line is returned to service or transmission network loading levels are otherwise relieved.

The load shedding controls are denoted System Protection Schemes and such schemes are already applied in various forms in other parts of the NSW network and are common in international practice. The shedding of load would need to be managed by a comparable reduction in generation in the interconnected southeast Australian system. Care would need to be taken to ensure that the generation reduction occurred in a location that led to an offloading of the critical transmission line. For example if the load shedding was undertaken in Sydney and generation in the south of the State or in Victoria or South Australia was reduced, the net power transfer into the north of NSW would appear to remain relatively constant and the loading in the critical lines may not be relieved. In contrast, for example, if the generation in Queensland was to be reduced in line with the Sydney area load reduction, the net transfer into the Newcastle – Sydney - Wollongong area from the north would be reduced as required.

Demand side options are addressed in Section A4.3.4 of Appendix 4.

A3.2.2 Voltage Control Capability

The voltage control issues on the NSW main transmission network reflect the high power transfers to the Newcastle - Sydney – Wollongong area over the relatively long distances from the major power sources in the north, west and south of NSW.

Reactive power support to the main transmission network has been provided for many years through the installation of switched shunt capacitor banks and Static VAr Compensators (SVC). An important component of the reactive power support is also the MVAr capability of generators. A fundamental assumption in the planning of the NSW main transmission network has always been that the full MVAr capability of generators would be available to support the main transmission network.

TransGrid has derived the values for the full MVAr capability based on its knowledge of the generator capabilities.

It should be noted that the full MVAr capability of the generators (according to TransGrid's understanding) significantly exceeds the performance standard for the generators (NER). Table A3.4 compares TransGrid's view of the generator MVAr export capability with the performance standard levels. NEMMCO is required to manage the difference between the performance standard levels and the maximum generating capability by entering into contracts for network control ancillary services.

Table A3.4 Generator MVAr Export Capability

Power Station	Performance Standard Reactive Generating Capability (of each unit) (MVAr)	TransGrid assumed Reactive Generating Capability (of each unit)
Bayswater	320	410 MVAr at 660 MW
Liddell	93	335 MVAr at 700 MW
Eraring	320	310 MVAr at 500 MW
Vales Pt	320	410 MVAr at 660 MW
Munmorah	145	410 MVAr at 660 MW
Wallerawang	112 – 161	200 MVAr at 300 MW
Mt Piper	320	200 MVAr at 500 MW

The reactive power support requirements of the main transmission network are also dictated by load power factors and MVAr losses (reactive losses) in the network (which result from flows on transmission and distribution lines). The overall customer MW load in the Newcastle – Sydney – Wollongong area is growing and, with it, the network MVAr losses.

Should one of a number of critical transmission lines supplying the Newcastle - Sydney – Wollongong area be forced out of service at times of high demand, the MW loadings and consequently the MVAr losses on the remaining lines increase, giving rise to a need to provide reactive capability that enables adequate voltage levels to be maintained in the area under these conditions.

This limitation has been managed in the past by the installation of reactive plant however there is limited scope to continue this strategy. There are now about 3,300 MVAr of shunt capacitors installed at 330kV and 132 kV in the Newcastle – Sydney – Wollongong area. In recent years TransGrid has been installing capacitor banks rated at 330kV and 200 MVAr in order to manage the reactive supply situation. In addition the SVCs at Sydney West and Kemps Creek provide dynamic reactive support.

The voltage control capability of the system is a function of the generating units on line and their power output. The reactive support afforded by the generators in the Newcastle – Sydney – Wollongong area is more critical than those at more distant locations. The Central Coast power stations are reasonably effective in supporting the load area voltages, particularly in the Sydney area. The reactive power capability of the Hunter Valley and western power stations are also important in supporting the sending end of the transmission network but provide less reactive support to the area than the Central Coast generators. Snowy reactive power capability is important in supporting the voltages in the immediate Snowy area but as Snowy is distant from the Newcastle – Sydney – Wollongong area it does not directly contribute to voltage control in that area.

The voltage control capability of the supply to the Newcastle – Sydney - Wollongong area is relatively independent of the level of import from the south of the State or north of the State for any given output from the thermal power stations in the State. For example under peak load conditions, with all presently installed reactive support plant in service and with most of the NSW generators in service, the capability for supplying the Newcastle – Sydney – Wollongong area varies with the import from the southern system as shown in Table A3.5.

In establishing the values in this table the same approach was taken as described for Table A3.3. The NSW thermal generation has been assumed to be at its maximum. Three levels of import from the south are illustrated. As the import from the south was varied the import from Queensland was then adjusted to match the overall demand in the State.

Table A3.5 Variation of Supply Capability with Import from the South

Import from the South	Capability to Supply the Newcastle – Sydney – Wollongong Area Based on Voltage Control Limitations
2,800 MW	10,560 MW
3,000 MW	10,578 MW
3,200 MW	10,577 MW

As the import from the north or south increases a point is reached where the supply capability will decline as a result of increasing reactive power losses (which varies in a square law relationship).

The capability to supply the Newcastle – Sydney – Wollongong area is very dependent on the number of generators connected in the Central Coast. Table A3.6 shows the load supply capability with all Central Coast generators in service, with one Munmorah unit off-line and with two Munmorah units off-line. In the table the import from the south has been fixed at 3000 MW. The capability is compared to the 10% PoE (medium economic growth) load levels for summer 2007/08 and 2008/09 (medium economic growth load forecast).

Table A3.6 Variation of Supply Capability with Central Coast Generation

	Approximate Load Supply Capability	Excess Supply Capability Compared to Load Summer 2007/08	Excess Supply Capability Compared to Load Summer 2008/09
All Central Coast generators in service, import from south 3,000 MW	10,770	87	-217
One Munmorah unit out of service, import from south 3,000 MW	10,580	-103	-407
Both Munmorah units out of service, import from south 3,000 MW	10,380	-303	-607

TransGrid plans to install further major capacitor banks in the Sydney area to meet the loads of summer 2006/7 and 2007/08. It is expected that the supply deficits shown above in summer 2007/08 will be able to be managed through the installation of a further 800 MVAr to 900 MVAr of capacitor banks.

At present there is also scope to alleviate the voltage control limitations if necessary by appropriate dispatch of generation in NSW. The ability to schedule generation to manage this voltage control limitation will decrease as the State aggregate customer demand approaches the level where, to meet it, all existing generation within the State and high levels of power import from Snowy/Victoria and Queensland are required.

There are two limitations to the further installation of reactive support, particularly in the Sydney area:

- The space available for the installation of major shunt capacitors in the Sydney area is now very limited; and

- There are technical limits to the degree to which shunt capacitor compensation can be used to maintain the power transfer capability of an electric power system. As the loading on the transmission network grows there is a need to manage voltage levels using static capacitors, SVCs and control systems. At relatively high levels of customer demand for electricity, a point is reached where these means are no longer adequate and the transmission capability needs to be improved by other means which may include the construction of new transmission lines.

It is expected that virtually all the accessible space for installation of capacitor banks in the Sydney area TransGrid substations will be used by summer 2007/08. In addition, by this time, the technical limits to shunt compensation will limit further major capacitor bank installations[18].

It is expected that due to the practical limits of capacitor installation in the Sydney area other means will need to be applied to ensure reliability of supply to the Newcastle – Sydney – Wollongong area in summer 2008/09 (medium economic growth forecast scenario). The limitation is expected to arise in summer 2007/08 under the high economic growth forecast and in 2009/10 under a low economic growth forecast[19].

Demand Side Remedial Options

As discussed in Section A3.2.1, one option to manage this limitation is to reduce customer demand in the Newcastle – Sydney – Wollongong area (or alternatively to supply some of the load from new generation in the area) in anticipation of an outage of the critical transmission lines.

[18] In technical terms the level of shunt compensation results in increasing voltage at the point of voltage collapse to the point where the collapse point approaches the normal operating voltage levels of the system.
[19] TransGrid Revenue Reset application to ACCC 2004.

The option to rapidly reduce the local customer demand following an outage of one of the critical transmission lines remains, however the load shedding would need to be significantly quicker than would be the case to manage line rating limitations. The load shedding to manage the voltage control limitation would need to be effected within a second or at most a few seconds following an outage of one of the critical lines.

The load shedding controls would be automatic and would be armed at times when the 330kV transmission system capability is approached. Again, as the 330kV transmission lines are very reliable, it is expected that the load shedding would have a low probability of being required. Once shed, the load would need to remain off until the line is returned to service or transmission network loading levels are otherwise relieved.

Such load shedding controls are also categorised as System Protection Schemes and such schemes have been applied in international practice. Again the shedding of load would need to be managed by a comparable reduction in generation in the interconnected eastern Australian system. Care would need to be taken to ensure that the generation reduction occurred in a location that led to a reduced loading on the transmission system.

The demand side options are addressed in Section A4.3.4 of Appendix 4.

A3.2.3 Dependency of Network Limitations on Demand Levels and Location of New Generation

By about the summer of 2008/09 it will be necessary to increase the power transfer capability of the core transmission network between the Hunter Valley and southern areas.

Alternatively:

- The loading on the transmission network will need to be maintained at acceptable levels through management of load; or

- New generation would need to be installed at appropriate locations.

Management of load would involve load reductions in the greater Sydney area either:

- At times of high demand in anticipation of the outage of a critical transmission line; or

- Following an outage of a critical transmission line.

  In this case, customer load shedding would need to be effected immediately following the outage to avoid potential voltage collapse on the network. It would also be necessary to rapidly adjust generation patterns in a strategic manner to ensure that critical parts of the transmission network are successfully off-loaded. Similarly load would need to be reduced to overcome line rating limitations.

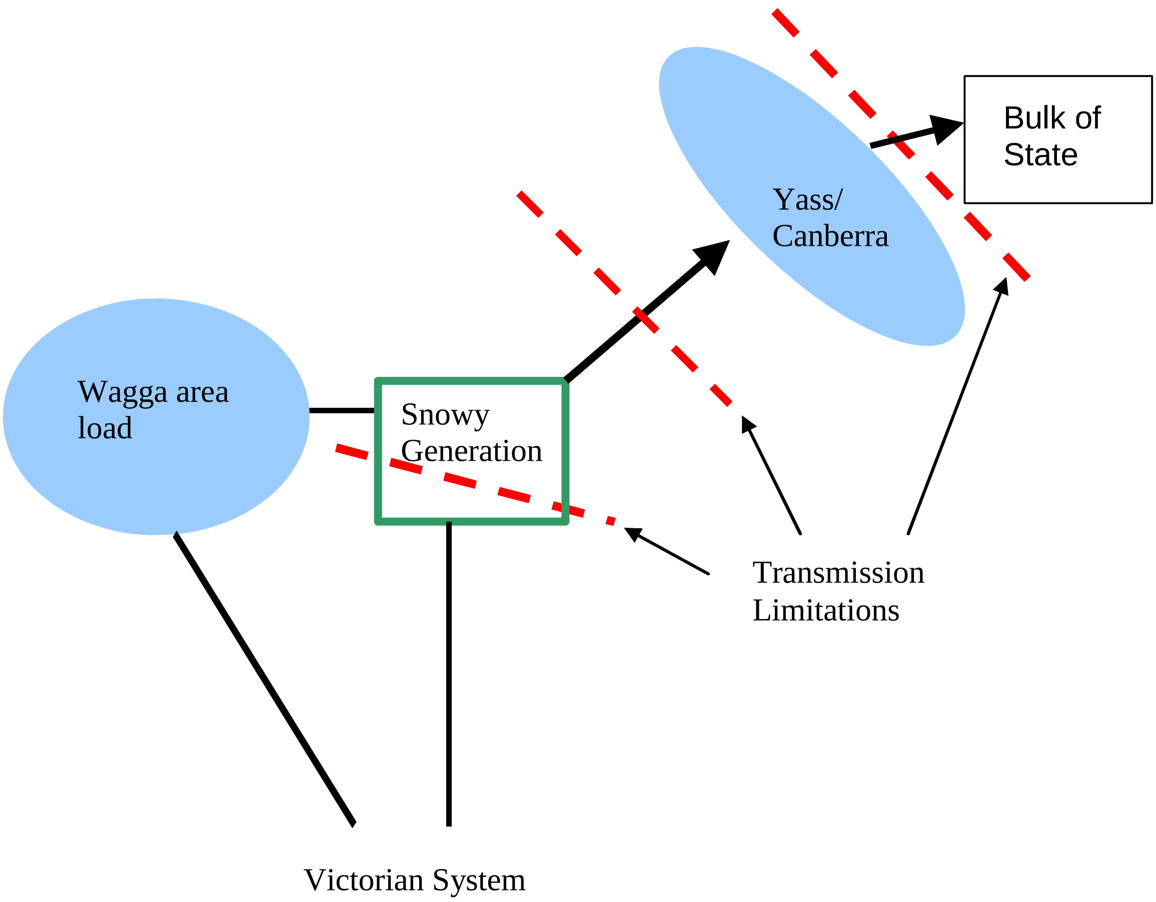
The customer demand could be restored once the faulted line has been restored to service or the power system loading conditions have eased.

Any additional generation installations would ideally need to be located within the NSW main network between the Newcastle and Wollongong areas. However, the effectiveness of new generation in relieving the network limitations will be affected by an additional network limitation described in Section A3.2.4.

There are power transfer limitations in the Snowy system, immediately north of Snowy between Snowy and Yass / Canberra and between Yass / Canberra and the Sydney and south coast areas. The limitations are shown indicatively in Diagram A3.10. The limitations are primarily governed by line thermal ratings but voltage control limitations arise in the Canberra area. The discussion of Sections A3.2.1 and A3.2.2 has illustrated the voltage control limitations that also arise in transmitting power from the south to the Newcastle – Sydney – Wollongong area.

Hence any new generation south of the Yass / Canberra area is not likely to be effective in meeting the NSW aggregate peak customer demand requirements, without an upgrading of the southern transmission network and without addressing the overall voltage control limitation on transmitting power to the Newcastle – Sydney – Wollongong area.

Diagram A3.10 Snowy to New South Wales Network Limitation



A3.2.4 Short Circuit Level Limitations

In addition to the limitations described in Sections A3.2.1 and A3.2.2 and those outlined in Section A3.2.3, it is also necessary to ensure that switchyard plant is operated within its short circuit rating.

A number of 330kV switchyards at the major power stations in the Hunter Valley and Central Coast have short circuit levels which are at or near the limit of the capability of the plant. There is limited capability to accommodate the connection of new generating plant to the NSW 330kV network without remedial action. There is considered to be no scope for upgrading the short circuit rating of the Bayswater and Liddell 330kV switchyards.

The capability of the network to accommodate new generating plant is dependent on the location of the new generation and its technical parameters. Generally new generating plant in the Central Coast to Hunter Valley area would be expected to significantly exacerbate the short circuit level restrictions in the area and hence only limited new plant would be able to be connected to the network. New generating plant south of Sydney is electrically more remote from the critical switchyards and there is generally more scope for such installations.

TransGrid is actively assessing the extent of short circuit level remedial works required to accommodate new generation following a number of Connection Applications for new generation in the Central Coast to Hunter Valley area and also at various sites in the southern area of the network.

The remedial action being considered includes the uprating of switchyard plant (where feasible), the rearrangement of connections to switchyards and the insertion of series reactors.

One network option is the upgrading of the western system to 500kV operation (refer to Section A4.2.1 of Appendix 4). This option effectively reduces the short circuit levels at the Hunter Valley 330kV switchyards. It is considered that this network option would enable the connection of limited additional generation to the 330kV network in the Hunter Valley to Central Coast area. This option therefore provides one means for assisting in the management of the short circuit level restrictions. It is possible that the other remedial actions being considered (plant uprating, line rearrangements and series reactors) will not be technically feasible or economic and a stage may be reached where the western system will need to be converted to 500kV operation just to enable the development of additional generation in NSW. The timing for the conversion would be specifically dependent on the new generation developments.

In assessing the options for generation development (as a non-network option) the following assumptions have been made concerning the capability of the network to accept new generation:

Table A3.7 Short Term Impact of Additional Generation on the Hunter Valley Short Circuit Level Limitation

Generation Site	Installed Capacity Limited by Short Circuit Limitations in the Hunter Valley
Central Coast to Hunter Valley	Up to 300 MW of plant is able to be connected
Sydney to the south around Marulan	No limitation due to short circuit levels
South of Yass / Canberra	No limitation due to short circuit levels
Capacity expansion of existing 660 MW units	No limitation due to short circuit levels (providing the plant main electrical parameters are unchanged)

It should be noted that the above applies in assessing generic generation options. However in practice any new generating plant installed anywhere on the network causes an increase in short circuit levels at all locations. Hence the cumulative effect of multiple new generators in the south of the State would also lead to short circuit level issues in the Hunter Valley. The situation would be assessed as each case arises in the Connection Application process.

A4 Appendix 4 - Options Considered

NOTE: The information contained in this Appendix is based on Section 4 of TransGrid's "Final Report, Proposed New Large Transmission Network Asset, Development of Supply to the Newcastle - Sydney - Wollongong Area, October 2006". This document can be found in Appendix 12 or on TransGrid's web site http://www.transgrid.com.au/trim/trim224993.pdf

The proposed works are required to meet minimum network performance requirements set out in the NER and by the New South Wales jurisdiction. Failure to implement measures to overcome the system constraints in the required timeframe would result in the minimum network performance standards not being met. Consequently, "do nothing" is not an option and would result in unacceptable levels of supply reliability in the core NSW network.

A number of network and non-network options having potential to relieve the line loading and voltage control limitations have been considered. These are discussed in the following sections.

A4.1 Timing of Options

The timing of implementation of options will be determined by system analysis taking into account the reliability criteria, load forecast and likely generation scenarios. Where network support is a feasible alternative, the timing of this has been taken into account in the application of the regulatory test (see Appendix 6). System analysis (see Appendix 3) has shown that reliability criteria will not be met from summer 2008/09 onwards. Consequently, some action needs to be taken by that time and can not be deferred to a future Regulatory Period.

A4.2 Network Options

Seven network options were considered.

Four of the network options considered below involve the establishment of sections of a future 500kV "ring" connecting the major load centres (Newcastle, Sydney and Wollongong) to the existing major thermal power stations. It is anticipated that in the longer term it will be necessary to complete the 500kV ring to serve the growing demand for electricity in NSW and new power stations developed to meet that demand. The optimal staging of these works depends on the location of future major generation within the State, which is at present unclear.

Two options involve an upgrade of transmission capacity from the Snowy area to Sydney by upgrading a number of existing 330kV lines plus establishment of a 330kV switching station at Bannaby.

The seventh option involves series compensation of existing lines.

A4.2.1 Option 1: Convert the Bayswater – Mount Piper – Marulan Line to 500kV Operation, Transfer Bayswater Units 3 & 4 to the 500kV Switchyard and Selected Line Upratings

The main works include:

- At Bayswater:
  - Establishment of a 500kV switchyard at Bayswater adjacent to the existing 330kV switchyard;
  - Connection of the two switchyards by two 500/330kV transformers;
  - Connection of two 150 MVAr shunt reactors to the transformer tertiaries;
  - Reconnection of the existing Mt Piper/Wallerawang line at Bayswater to the 500kV switchyard (the remote ends are to be reconnected to Mt Piper and Wollar); and
  - Reconnection of generator units 3 and 4 at Bayswater from the 330kV switchyard to the 500kV switchyard.

- At Mount Piper:
  - Establishment of a 500kV switchyard at Mt Piper adjacent to the existing 330kV switchyard;
  - Connection of the two switchyards by two 500/330kV transformers;
  - Connection of two 150 MVAr shunt reactors to the transformer tertiaries;

- Reconnection of the existing Bayswater circuit from the 330kV switchyard to the 500kV switchyard;
    - Connection of a Wollar circuit to the 500kV switchyard;
    - Reconnection of the existing Marulan line from the 330kV switchyard to the 500kV switchyard;
    - Connection of the existing 330kV circuit, which presently connects one of the 500kV circuits to Bayswater, to Mount Piper to form a second Mount Piper – Wallerawang 330kV circuit; and
    - Relocation of the existing Wellington line within the 330kV Switchyard.

- At Bannaby:
    - Establish a new 500/330kV substation including 500kV and 330kV switchyards, two 500/330kV transformers and two 150 MVAr shunt reactors connected to the transformer tertiaries;
    - Connect two 500kV circuits to Mount Piper; and
    - Connect 330kV circuits to Yass, Sydney West and two to Marulan.

- At Wollar:
    - Convert 500kV switchgear operating at 330kV to 500kV operation;
    - Install a 500/330kV transformer and 330kV switchbay; and
    - Reconnect the Wellington 330kV circuit to the new 330kV switchbay.

Additional works that form part of this option are as follows:

- At Wallerawang 330kV Switchyard:
    - Uprate equipment to ensure adequate fault level ratings.

- Carry out uprating works on the following 330kV circuits:
    - Marulan – Avon;
    - Marulan – Dapto; and
    - Kangaroo Valley – Dapto.

- Modify 330kV line protections in the Bayswater – Liddell area.

This option involves establishment of 500/330kV substations at Bayswater, Wollar, Mount Piper and Bannaby (near the intersection of the Sydney West – Yass 330kV line and the Mount Piper – Marulan 500kV line).

The existing 330kV switchyards at Bayswater and Mount Piper were established with provision for the future installation of 500kV switchyards and 500/330kV transformers.

A switchyard is proposed to be constructed at Wollar, to connect the proposed Wollar – Wellington 330kV line to the existing Bayswater – Mt Piper/Wallerawang line. This switchyard is to be equipped with 500kV switchgear to facilitate its conversion to a 500/330kV substation.

Uprating of the 330kV Marulan – Dapto, Marulan - Avon and Kangaroo Valley – Dapto lines is required to provide for increased power flows on these lines following conversion of the Bayswater – Mt Piper – Bannaby line to 500kV operation.

Some equipment at Wallerawang would be required to be uprated to provide for increased short circuit level duty.

This option provides increased capability to supply the load of the Newcastle – Sydney – Wollongong area. Specifically:

- It permits increased power flow from the north to the south via the Bayswater - Mt Piper - Bannaby 500kV lines, reducing the loading on the Liddell to Tomago / Newcastle lines. It provides additional supply capability to the Newcastle - Sydney - Wollongong area as discussed in detail in Appendix 5.

- It relieves the voltage control limitation on supply to the Newcastle - Sydney - Wollongong area:

    - By off loading 330kV lines it improves the overall system voltage control capability, allowing higher power transfer from the Hunter Valley, western and southern generation to the area.
    - By reducing the overall network impedance between Bayswater and Bannaby it permits a high level of access to the MVAr generating capability of the Hunter Valley and western generators from the area; and
    - It increases reactive support due to increased line charging.
- The line uprating in the southern network alleviates past limitations on power transfer between Marulan and the coastal area that has constrained southern and western generation levels.

Reconnection of the No. 3 and No.4 units at Bayswater to the 500kV switchyard would reduce short circuit levels at the Bayswater and Liddell 330kV switchyards. This would allow a limited range of future generation developments to occur without major upgrades being required at these sites for short circuit level reasons.

This option would take approximately 3½ years to construct with an estimated completion date being early 2010. Transfer of the Bayswater units to the 500kV switchyard would be co-ordinated with scheduled major outages of those units. The works other than transfer of the No.3 unit at Bayswater to the 500kV switchyard would be completed prior to summer 2009/10. The staged development of the option to coordinate with major generator outages results in a staged improvement of supply capability with some additional capability available in summer 2009/10.

A number of timing and staging variations of this option are being considered. The construction sequence for the project needs to be coordinated with the program of generator outages for major maintenance at Bayswater. Options are also being considered that would remove this constraint on the construction sequence.

This option does not have a material inter-network impact (Clause 5.6.2A b (v) of the NER).

A4.2.2 Option 2: Convert the Bayswater – Mount Piper – Marulan Line to 500kV Operation without Transfer of Bayswater Units 3 and 4 to the 500kV Switchyard

This option is essentially the same as the previous option, except that No. 3 and No.4 units at Bayswater remain connected to the 330kV Switchyard.

This option would take approximately three years to construct with an estimated earliest completion date being late 2009. As per the previous option a number of timing and staging variations of this option are being considered.

This option provides relief of the line loading issue with the Liddell – Tomago / Newcastle lines as discussed in detail in Appendix 5. In conjunction with the work being carried out for Option 1, in assessing the potential to remove the linkage between the construction sequence of the project and the scheduling of maintenance on the Bayswater 3 and 4 units, it may be possible to improve the power flow capability benefits.

The conversion of the Bayswater- Mt Piper line to 500kV operation marginally increases the short circuit level at the 330kV switchyards in the Hunter Valley and hence further remedial action is required with this option to allow the Bayswater 3 and 4 units to remain connected to the 330kV switchyard.

A4.2.3 Option 3: Bayswater – Newcastle/Eraring Line

This option would involve construction of a double circuit 500kV line between Bayswater and Eraring, together with the establishment of a 500/330kV substation at Richmond Vale or Kurri (in the Newcastle area) to supply the Newcastle area.

Environmental approval for this line would be very difficult to obtain at this point in time because:

- Until the location of future generation is known it cannot be demonstrated that this line would be the most appropriate short to medium term development. For example, if future generation was in the south of the State, constructing a line between Bannaby and Sydney could be more appropriate.

- Options which do not involve construction of a new line are viable.

There is also considerable risk of construction being delayed due to the extensive environmental consultation required for the line.

Consequently, obtaining environmental approval for and construction of this option is not considered to be practicable in the time available. This option has therefore not been considered for input to the regulatory test.

However, it has been included as a future transmission development in the regulatory test scenarios as a means of overcoming future constraints in the NSW core network over the longer-term horizon.

A4.2.4 Option 4: Bannaby – Sydney Line

This option would involve construction of a double circuit 500kV line between Bannaby and Sydney, most probably utilising part of the route of the existing Yass – Sydney West 330kV line and construction of a 330kV switching station at Bannaby. Depending on future generation developments, the new line could operate at 330kV for a number of years.

As with the previous option, environmental approval would be very difficult to obtain because:

- Until the location of future generation is known it cannot be demonstrated that this line would be the most appropriate short to medium term development. For example, if future generation was in the north of the State, constructing a line between Bayswater and Newcastle/Eraring could be more appropriate.

- Options which do not involve construction of a new line are viable.

There is also considerable risk of construction being delayed due to the extensive environmental consultation required for the line.

Consequently, obtaining environmental approval for and construction of this option is not considered to be practicable in the time available. This option has therefore not been considered for input to the regulatory test.

However, it has been included as a future transmission development in the regulatory test scenarios as a means of overcoming future constraints in the core network over the longer-term horizon.

A4.2.5 Option 5: Southern 330kV Upgrade by 300 MW

This option was developed following the SnowyHydro Limited submission to TransGrid's paper of September 2005 describing the expected transmission network limitations. Whilst it does not overcome those limitations, it is an option to improve supply capacity to the Newcastle – Sydney - Wollongong area in the medium term.

The capability for Snowy export to NSW is dependent on the rating of the Murray Switching Station to Upper Tumut Switching Station and Lower Tumut Switching Station 330kV lines. The ratings of these lines are being investigated. At this stage TransGrid is pessimistic as to the potential to undertake any substantial uprating of these two lines.

North of Snowy the power transfer capability is limited by the following factors:

- The rating of the four Snowy to Yass / Canberra 330kV lines;
- The rating of the two Yass to Marulan 330kV lines;

- The rating of the Yass to Sydney West 330kV line;
- The rating of the Marulan to Avon / Dapto and Kangaroo Valley – Dapto lines;
- Voltage control at Canberra; and
- Voltage control in meeting the load of the Newcastle – Sydney – Wollongong area.

TransGrid has investigated the works that would be required to upgrade the power transfer capability from the south by 300 MW.

The works of this option involve:

- Uprating of various sections the following 330kV lines:
  - Upper Tumut – Yass ;
  - Lower Tumut – Yass;
  - Upper Tumut – Canberra;
  - Lower Tumut – Canberra;
  - Marulan – Avon;
  - Marulan – Dapto; and
  - Kangaroo Valley – Dapto.

- Establishment of a 330kV switching station at Bannaby

- Reactive power support

The development of a substation at Bannaby would reduce the level of line uprating required east of Marulan.

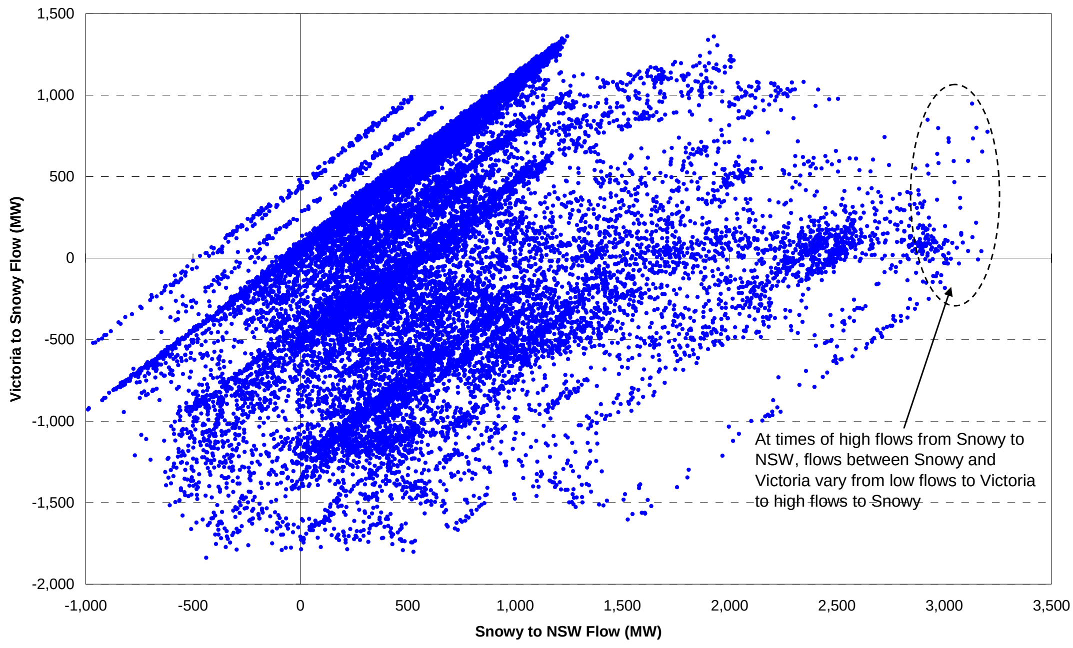
It should be noted that the line uprating work would require the lines to be taken out of service. The feasibility of these outages has not been examined.

TransGrid has assessed the line thermal rating limit north of Snowy at about 3200 MW under normal system conditions. TransGrid would expect that there would be sufficient generating capability within Snowy (and possibly supported by Victoria) to reliably provide power to NSW up to this level on hot summer days, in a peaking pattern[20], from the south.

Diagram A4.1 shows the NSW import from the south against the Victorian import for summer of 2005/06. This data is typical of most summers.

[20] The Snowy system is energy limited and hence will only be able to provide high levels of generation in peaking patterns.

Diagram A4.10 NSW Import from the South and Victorian Import



On the rare occasions when there was high import by NSW, Victoria generally provided limited support. At very high levels of import the Victorian export contribution varied from about 1,000 MW down to zero. At times Victoria was also importing coincidently with NSW.

The capability for power transfer to the north of Murray (i.e. the combined output of Murray plus Victorian export to Snowy) is limited by the rating of the two 330kV lines north of Murray (as discussed above). TransGrid does not have a high degree of confidence that an additional 300 MW of generating capability would be available for support of the Newcastle – Sydney – Wollongong load.

This view is supported by the market simulation analysis carried out by NEMMCO for the 2005 ANTS. NEMMCO examined the total market benefits of the Snowy to NSW interconnector. The benefits from augmenting this interconnector appear to be relatively small, compared to the other interconnectors.

Increased power flows from Snowy/Victoria would increase reactive losses in the network between Snowy and Sydney. To manage the voltage control issues addressed in Section A3.2.2 of Appendix 3 it would be necessary to have completed the western 500kV conversion.

As this option on its own does not overcome the expected network limitations, it has not been considered in the regulatory test. However, in the medium term, once the presently expected transmission limitations have been relieved, it could provide additional capacity to supply the Newcastle - Sydney - Wollongong area and would be considered for inclusion in a separate application of the regulatory test at the appropriate time.

A4.2.6 Option 6: Southern 330kV Upgrade by 500 MW

As with Option 5, this option was developed following the SnowyHydro Limited submission to TransGrid's paper of September 2005 describing the expected transmission network limitations. Whilst it does not overcome those limitations, it too is an option to improve supply capacity to the Newcastle – Sydney - Wollongong area in the medium term.

Similar to Option 5, TransGrid has assessed the works required to achieve an increased import capability of 500 MW.

TransGrid expects this option would involve:

- Uprating of the following 330kV lines by re-conductoring the lines with high temperature alloy conductors:

- Upper Tumut – Yass;
  - Lower Tumut – Yass;
  - Upper Tumut – Canberra;
  - Lower Tumut – Canberra;

- Uprating of various sections of the following 330kV lines:
  - Yass to Marulan (2 lines);
  - Marulan – Avon;
  - Marulan – Dapto; and
  - Kangaroo Valley – Dapto.

- Establishment of a 330kV switching station at Bannaby

- Reactive power support.

Similar reservations as with Option 5 apply.

The voltage control at Canberra may need to be of a dynamic form (SVC).

Increased power flows from Snowy/Victoria would increase reactive losses in the network between Snowy and Sydney. To manage the voltage control issues addressed in Section A3.2.2 of Appendix 3 it would be necessary to have completed the western 500kV conversion.

As this option on its own does not overcome the expected network limitations, it has not been considered in the regulatory test. However, in the medium term, once the presently expected transmission limitations have been relieved, this option could provide additional capacity to supply the Newcastle - Sydney - Wollongong area and would be considered for inclusion in a separate application of the regulatory test at the appropriate time.

A4.2.7 Option 7: Series Compensation of Existing 330kV Lines

This option involves the installation of series capacitors in the following 330kV circuits:

- Bayswater – Regentville

- Bayswater – Sydney West

- Wallerawang – Sydney South

- Wallerawang – Ingleburn

In addition reactive support is required in the Sydney area.

The level of line series compensation is limited by the rating of the 330kV lines[21] and short circuit levels (series capacitance reduces line impedance and hence they will tend to increase short circuit levels).

This construction of this option is not considered to be practicable given the number of switchyards that would need to be uprated or reconstructed and the limited improvement to line loading capability.

[21] By reducing the line impedance there is a consequent increase in power flow through the line. As many of the 330 kV lines are operated close to their thermal rating the level of series compensation must be limited.

A4.3 Non-network Options

In September 2005 TransGrid published a consultation document entitled “Emerging Major Transmission Network Limitations in Supplying the Newcastle – Sydney - Wollongong Load Area” which, inter alia, sought proposals for non-network options.

Three submissions were received in response to this needs statement. The options proposed were:

- Establishment of a 400 MW combined cycle power station at Tallawarra;
- Establishment of a 400 MW combined cycle power station at Bamarang (near Nowra);
- Establishment of up to 600 MW open cycle gas turbine power station at Munmorah; and
- Use of the existing No. 1 and No. 2 units at Munmorah as synchronous condensers.

These options are addressed in the following sections.

A further option that arose out of the submissions involves uprating existing 330kV lines between Snowy and Sydney and establishing a 330kV switching station at Bannaby to increase transmission capacity between Snowy and Sydney. This is a network option and is discussed in Section A4.2.5 and A4.2.6 above.

A4.3.1 Combined Cycle Power Stations in the Wollongong/Nowra Area

The summer maximum demand for the State is forecast to grow by approximately 400 MW each year. Thus, each of the proposed combined cycle power stations could potentially accommodate one year of demand growth.

A4.3.2 Munmorah Open Cycle Gas Turbine Power Station

The 600 MW power station at Munmorah may be developed in two 300 MW stages. The first stage could potentially accommodate one year of load growth in the Newcastle - Sydney - Wollongong area. Commissioning of the second stage would however increase fault levels in the Hunter Valley and Central Coast to beyond the capability of the existing switchyards.

A4.3.3 Synchronous Condensers

Use of the presently disconnected No.1 and No.2 units at Munmorah as synchronous condensers offers the potential to defer installation of switched shunt capacitors in the Central Coast and Sydney area. However, they would increase short circuit levels in the Hunter Valley and Central Coast, which would require remedial action.

The installation of synchronous condensers does not address the Hunter Valley to Newcastle line rating limitation in supply to the load area.

A4.3.4 Ongoing Development of Non-Network Options

TransGrid has engaged CRA International (CRA) to assist it in the development of non-network options. This has entailed, inter alia, the issue, in August 2006, of a request for proposals (RFP) for non-network projects.

A number of submissions in response to the RFP have been received evaluated. The review of these submissions indicates that:

- The magnitude of non-network projects offered could be sufficient to manage the network limitations over summer 2008/09 and summer 2009/10; and
- The cost of implementing a portfolio of non-network projects could be up to \$15 - \$20 million for summer 2008/09 and at least \$70 million for summer 2009/10.

No single proposal could provide sufficient network support to allow deferment of network augmentation. However, combinations of the proposals were considered potentially suitable to defer network augmentation and were considered as an input to the regulatory test.

This information has been used by NERA when applying the regulatory test.

This network support is separate from the network support that is the subject of this Pass-Through Notice. This network support will be the subject of a separate Pass-Through notice that will be submitted to the AER when details of the estimated pass-through amount can be finalised. The pass-through amount cannot be finalised until contractual negotiations are completed.

A5 Appendix 5 - Planning Analysis of Options 1 and 2

NOTE: The information contained in this Appendix is based on Section A3.6 of Appendix 3 of TransGrid's "Final Report, Proposed New Large Transmission Network Asset, Development of Supply to the Newcastle - Sydney - Wollongong Area, October 2006". This document can be found in Appendix 12 or on TransGrid's web site http://www.transgrid.com.au/trim/trim224993.pdf

Option 1 involves the conversion of the Bayswater – Mt Piper – Bannaby system to 500kV operation and the transfer of the connections of Bayswater Units 3 & 4 to the proposed Bayswater500kV switchyard. The transfer of the unit connections involves the replacement of the existing generator transformers by appropriate 500 kV transformers and modification to the overhead lines connecting the transformers to the high voltage switchyard.

Option 2 retains the existing 330 kV connection of units 3 & 4.

The two options are compared below with respect to the following aspects:

- The power flow limitation between the Hunter Valley and the Newcastle area (Section A5.1);
- The power transfer capability south from the Hunter Valley (Section A5.2);
- The power transfer capability to the Newcastle – Sydney – Wollongong load corridor (Section A5.3);
- The voltage control limitation in supply to the Newcastle – Sydney – Wollongong load corridor (Section A5.4); and

A5.1 Power Flow Limitation – Hunter Valley to Newcastle area

In order to illustrate the relationship between the power transfer capabilities of Options 1 and 2 the power flows in the Hunter Valley area (in MW) are shown below for a particular generation dispatch supplying the summer 2008/9 forecast peak load (10% probability of exceedence, medium economic load growth).

For the purpose of illustration attention is focussed on the impact of an outage of the Liddell – Tomago 330 kV line, which is the critical outage determining the power transfer capability under the load and dispatch conditions considered. It is assumed that the additional losses that occur as a result of the contingency are supplied from the south of NSW.

The diagrams comparing the two options are labelled as follows:

Table A5.1 Diagrams Relating to Options 1 & 2

	System Normal – all elements in service	**Liddell – Tomago line out of service**
Option 1 network configuration (western 500 kV conversion with Bayswater units 3 and 4 connected at 500 kV)	Diagram A5.1	Diagram A5.2
Option 2 network configuration (western 500 kV conversion with all Bayswater units remaining at 330 kV)	Diagram A5.3	Diagram A5.4

The total import from Queensland is assumed to be 1100 MW. The following dispatch pattern is assumed for the power flow diagrams:

Table A5.2 Dispatch conditions

Power Station	Units Online	Station Generation MW
Redbank	1	148
Bayswater	4	2800
Liddell	4	2060
Mt Piper	2	1320
Wallerawang	2	1000
Eraring	4	2640
Vales Pt	2	1320
Munmorah	1	300

The following comments can be made about these illustrative conditions:

Option 1

- The 500 kV conversion (Option 1) causes a large portion of the output of the Bayswater units 3 & 4 to flow via the western system to Mt Piper. This offloads the Liddell – Newcastle area line.
- Following an outage of the Liddell – Tomago 330 kV line (Diagram A5.2) the full output of the Bayswater 3 & 4 units flows to the west. Following the outage, the remaining Liddell – Newcastle 330 kV line is loaded to about 1450 MW. This loading is equivalent to a current flow corresponding to about 1400 MVA at 330 kV, which is below the line rating of 1430 MVA (at 330 kV). Hence the Option 1 network configuration provides sufficient capability to accept the generation dispatch pattern in Table A5.3 whilst meeting the load in the Newcastle – Sydney – Wollongong load corridor.

Option 2

- Under the network configuration of Option 2, where all of the Bayswater units continue to be connected at 330 kV, there is also a relatively high power transfer from Bayswater to Mt Piper via the western system. For the generation dispatch conditions shown (and in general for any dispatch pattern) the power flow from Bayswater to Mt Piper would be lower than occurs for Option 1.
- Following the critical line outage the Liddell – Newcastle line (Diagram A5.4) would be loaded to about 1510 MW which is equivalent to a current flow corresponding to about 1455 MVA at 330 kV. This is above the line rating of 1430 MVA (at 330 kV) and hence it would be necessary to reduce the import from Queensland or reduce the output of the Hunter Valley generation.

Hence Option 1 has a higher power transfer capability than Option 2 with respect to the line rating limitation between the Hunter Valley and the Newcastle area.

These observations are summarised in the following table, which presents key data from Diagrams A5.1, A5.2, A5.3 and A5.4.

Table A5.3 Options 1 and 2 Compared – Power Flows

	System Normal		Line Outage	
	Option 1	Option 2	Option 1	Option 2
Diagram	A5.1	A5.3	A5.2	A5.4
Bayswater – West power flow (MW)	1100	980	1350	1200
Bayswater – Sydney power flow (MW)	1760	1830	2030	2110
Liddell – Tomago line flow (MW)	930	970	0	0
Liddell – Newcastle line flow (MW)	1030	1070	1450	1510

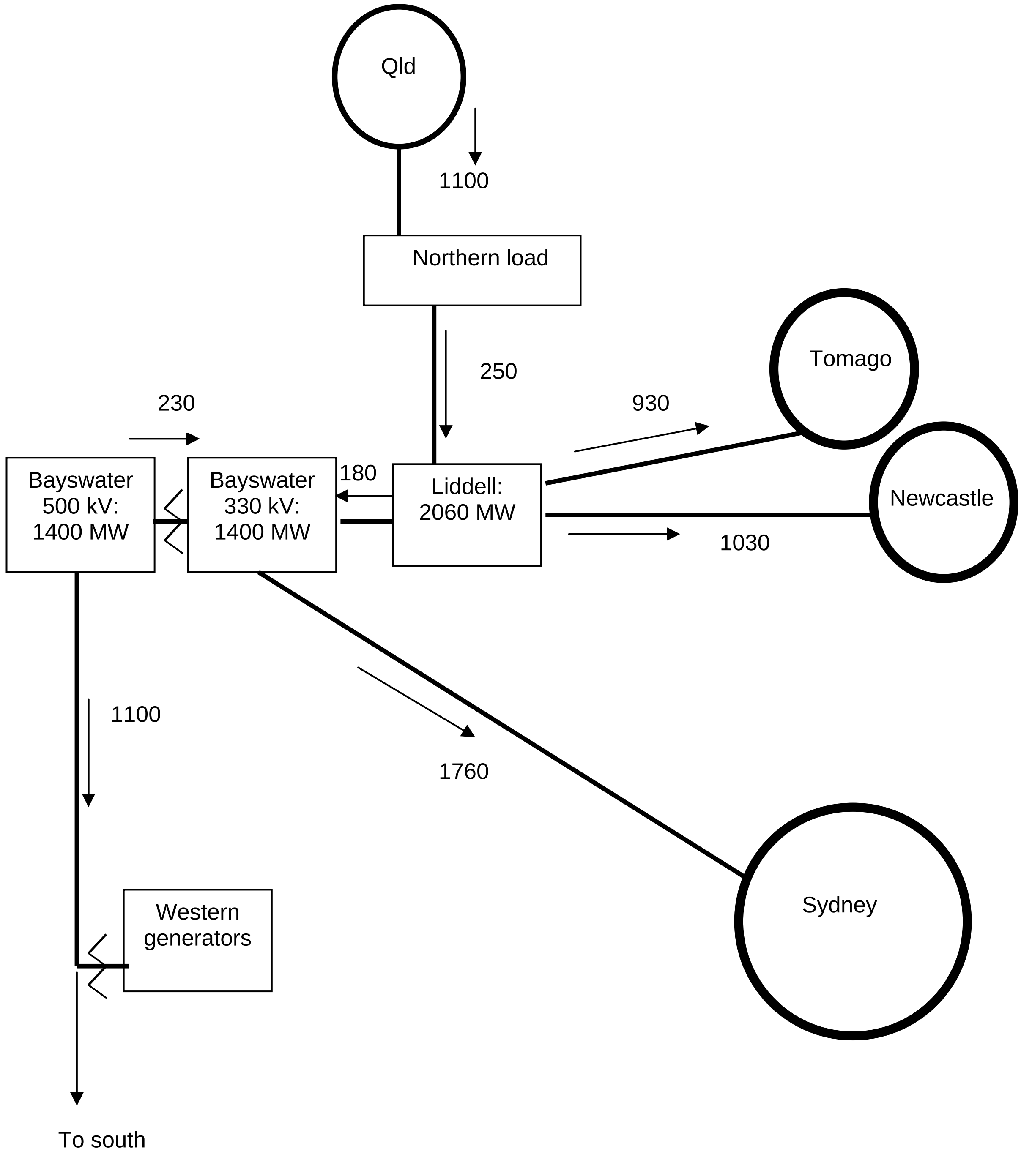


Diagram A5.1 – Option 1 - system normal

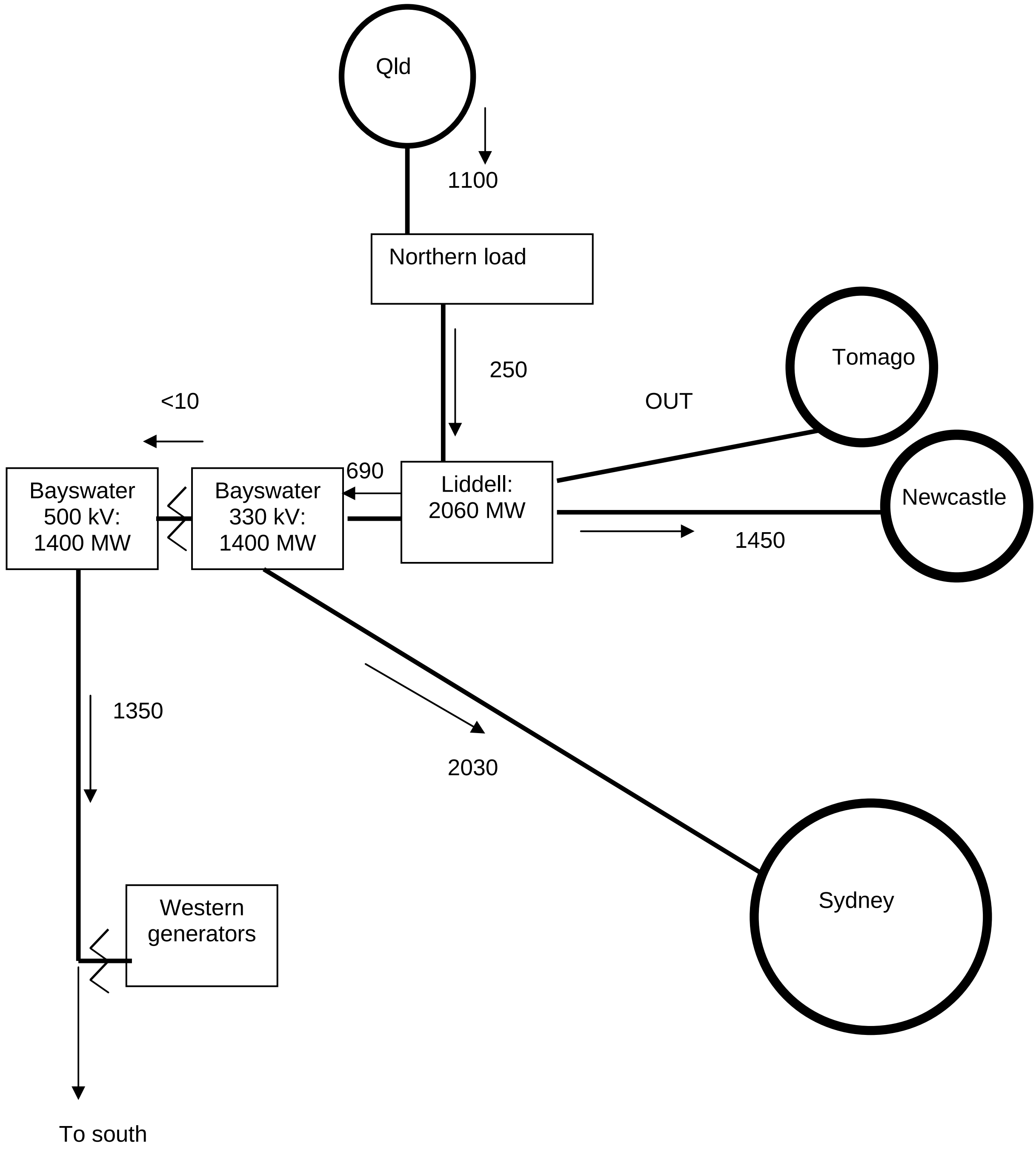


Diagram A5.2 – Option 1 – Line Outage

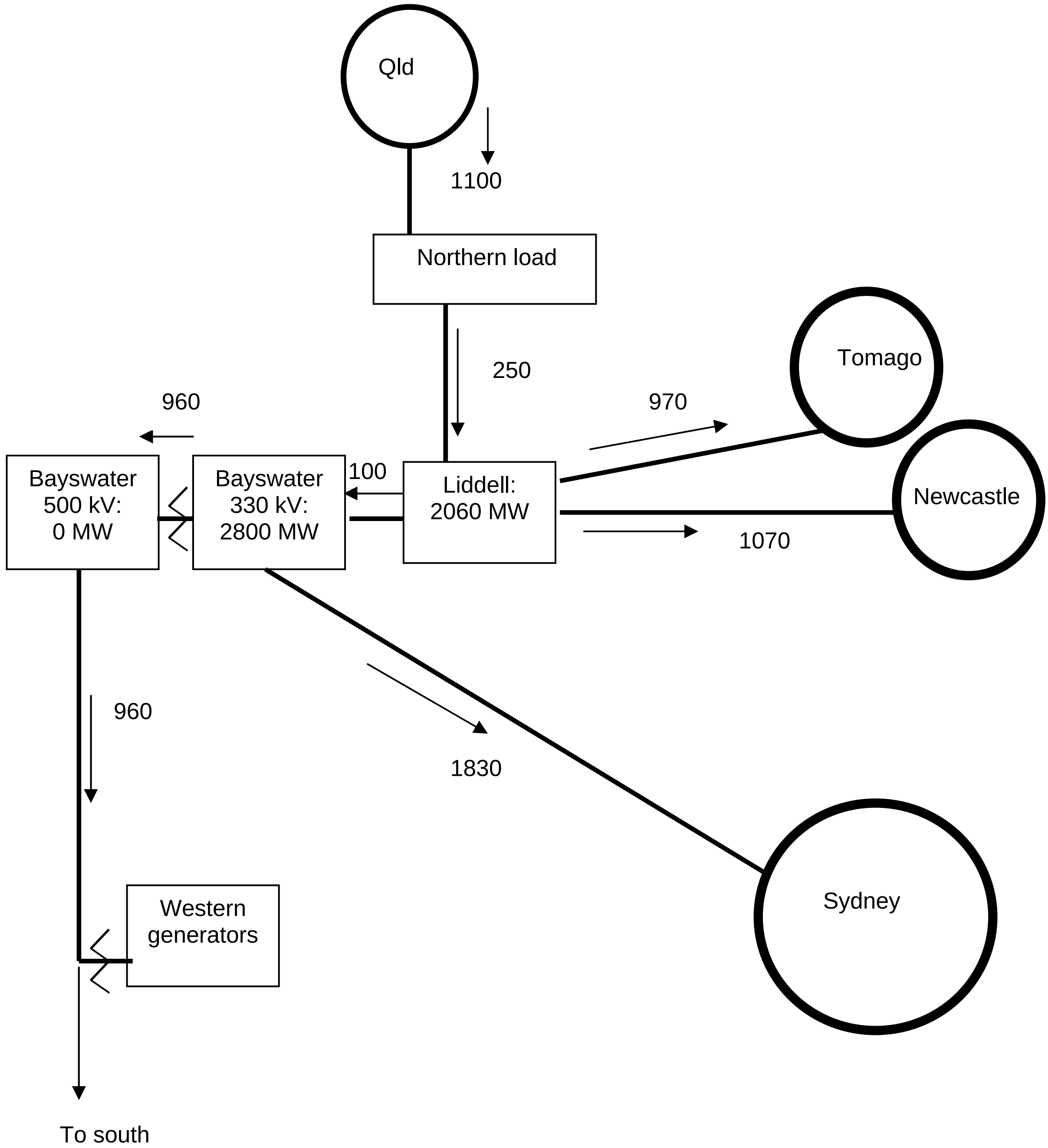


Diagram A5.3 – Option 2 - system normal

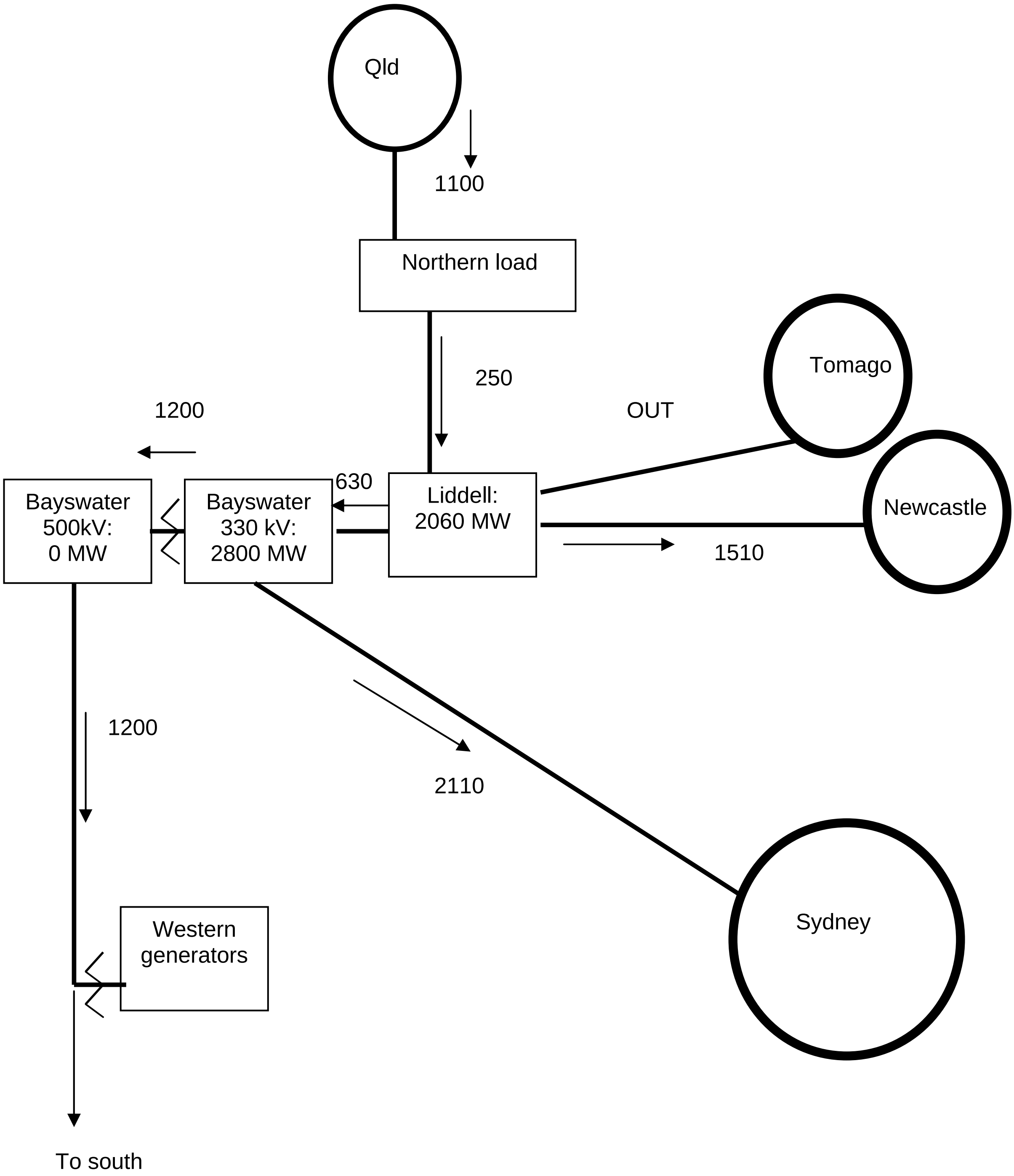


Diagram A5.4 – Option 2 – Line Outage

A5.2 Power Transfer Capability South from the Hunter Valley

The power transfer capabilities of Option 1 and 2 can be compared by assessing the capability of the options to accept the generation output in the Hunter Valley, combined with import to NSW from Queensland.

The patterns of line loadings and the relative benefits of Option 1 and Option 2 vary with system conditions. The capabilities of Option 1 and Option 2 are summarised below under conditions for summer 2008/9 – peak forecast load (10% probability of exceedence – medium economic growth scenario), 90% of this peak load and 80% of this peak load. Scenarios with one Munmorah unit in service, no Munmorah units on line, one Vales Pt unit off and one Eraring unit off are shown.

The values shown in the Tables A5.5 and A5.6 are the indicative levels of reduction in the combined output of the Hunter Valley power stations and NSW import from Queensland that would be required to meet line rating limitations. The levels of reduction relate to the following Hunter Valley generation levels and import from Queensland:

Table A5.4 – Generation and Import

Generation or Import		MW
Bayswater		2800
Liddell		2060
Redbank		148
Import from Queensland:	QNI	1100
	Directlink	180
	Total	**6288**

Due to the tight supply / demand balance in NSW applying to the forecast summer 2008/9 peak load there is limited capability to remove generating units in NSW from service. For example it is not feasible to remove a 660 MW unit and both Munmorah units at time of peak load.

Table A5.5 shows for Option 1 the reduction in MW (from the 6288 MW total of Table A5.4) that would be necessary to maintain the Liddell - Newcastle 330 kV line within rating following an outage of the Liddell – Tomago 330 kV line.

Table A5.5 - Option 1 – Supply from Hunter Valley – Generation Restriction

Load level	Munmorah -1 unit in service	Munmorah off-line	Vales Pt - 1 unit in-service + No Munmorah units in service	Eraring- unit 1 off-line + Vales Pt - 1 unit off line + Munmorah units off-line
Peak	10	260	-	-
90% peak	No reduction	90	480	-
80% peak	No reduction	No reduction	300	705

Table A5.6 shows the comparable MW reduction that applies for Option 2.

Table A5.6 - Option 2 – Supply from Hunter Valley – Generation Restriction

Load level	Munmorah -1 unit in service	Munmorah off-line	Vales Pt - 1 unit in-service + No Munmorah units in service	Eraring- unit 1 off-line + Vales Pt - 1 unit off + Munmorah units off-line
Peak	305	570	-	-
90% peak	145	400	790	-
80% peak	No reduction	240	610	1015

There is approximately a 300 MW difference in capability between the Option 1 and Option 2 with respect to the ability to accept generation in the Hunter Valley and import from Queensland.

A5.3 Power Transfer Capability to the Newcastle – Sydney Wollongong Load Corridor

The power transfer capabilities of Option 1 and 2 can also be compared by assessing the impact of the Hunter Valley – Newcastle area line loading limitation on the ability to meet the load requirements of the Newcastle – Sydney – Wollongong load corridor.

For the purpose of this assessment and illustration of the differences between the two options, the summer 2008/9 forecast load level in the Newcastle – Sydney – Wollongong load area (10% probability of exceedence load, medium economic growth) has been applied. Various levels of import from the south have been considered.

Consistent with Section A5.2 the following conditions are assumed to apply for this illustrative situation:

- All NSW thermal generators operate at their maximum output, except for Munmorah as shown in the table;
- Shoalhaven generation is not in service;
- No new generation is installed in NSW;
- The most critical condition is an outage of the Liddell – Tomago 330 kV line leading to a high loading on the Liddell – Newcastle 330 kV line; and
- The load in the Newcastle – Sydney – Wollongong load corridor varies proportionally to the peak 2008/9 summer load forecast. The Tomago smelter load is assumed to be constant.

Table A5.7 shows the difference in capability between Option 1 and Option 2. Option 1 has the higher capability.

Table A5.7 Supply Capability of Option 1 Compared to Option 2 – 2008/9

	Approximate Difference Between the Supply Capabilities in MW (Capability of Option 1 – Capability of Option 2) – 2008/9		
Import from south	**Central Coast generation 600 MW below maximum**	**Central Coast generation 300 MW below maximum**	**Maximum Central Coast generation operating (Note 1)**
2800	192	182	195
2900	180	180	193
3000	180	170	183
3100	194	174	187
3200	175	165	178

Table A5.7 is to be interpreted as per the following example:

With one Munmorah unit out of service and an import from Snowy / Victoria of 3000MW, Option 1 has the capability of supplying approximately 170MW more to the Newcastle – Sydney - Wollongong load corridor than Option 2.

TransGrid considers that the additional supply capability provided by Option 1 warrants the replacement of the Bayswater units 3 & 4 generator transformers.

A5.4 Voltage Control Limitation in Supply to the Newcastle – Sydney – Wollongong Load Corridor

The assessment of voltage control capability is discussed in Section A3.2.2 of Appendix 3. The voltage control capabilities of Option 1 and 2 are compared below.

Diagram A5.5 on the following page illustrates the supply capability of Option 1 and 2. The voltage at the Sydney West 330 kV busbar (in per unit) is plotted against the total supply point load (in MW) in the Newcastle – Sydney – Wollongong load corridor. The load MW is the sum of the TransGrid supply point loads in the load corridor. The voltage monitored ('y' axis) is at the Sydney West 330 kV bus.

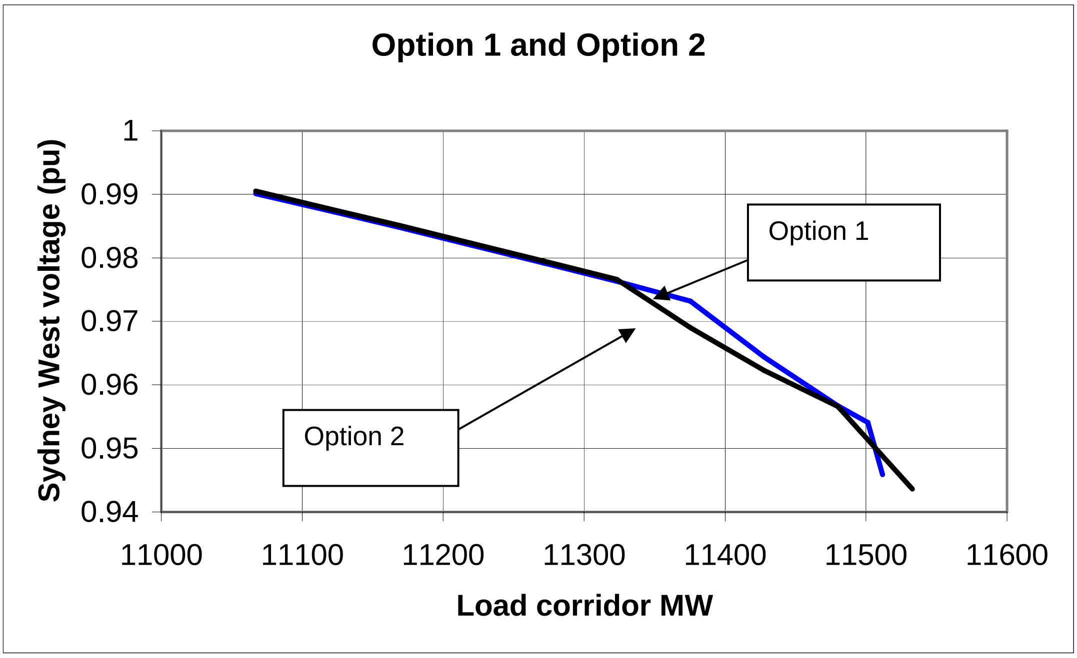
Under peak forecast load levels the following system conditions are assumed to apply:

- The generator MVAr export capability is as shown in Table A3.4, Section A3.2.2 of Appendix 3;
- The NSW load has been set at the 10% probability of exceedence forecast level (medium economic growth scenario) for summer 2008/9;
- All NSW thermal generators are assumed to operate at their maximum output, except that it is assumed that one Munmorah unit is in service;
- No new generation is installed in NSW;
- Shoalhaven generation is assumed to not be in service;
- The NSW import from Snowy / Victoria is fixed at approximately 3000 MW and the variation of the Newcastle - Sydney – Wollongong load is met by changing the NSW import from Queensland;
- All system capacitive support plant that is able to contribute to voltage control on the system is assumed in service; and
- TransGrid's planned capacitor bank installations for 2006/7 and 2007/8 are assumed in service.

In calculating the power transfer capability of the system it is assumed that the load in the Newcastle – Sydney – Wollongong load corridor varies proportionally to the peak 2008/9 summer load forecast. The Tomago smelter load is assumed to be constant. The load power factor is held constant.

Diagram A5.5 shows that Option 1 and Option 2 have similar maximum supply capabilities with respect to voltage control under these assessment conditions.

Diagram A5.5 Supply Capability



A6 Appendix 6 - Application of the Regulatory Test

NOTE: 1. The information contained in this Appendix is based on Section 5 of TransGrid's "Final Report, Proposed New Large Transmission Network Asset, Development of Supply to the Newcastle - Sydney - Wollongong Area, October 2006". This document can be found in Appendix 12 or on TransGrid's web site http://www.transgrid.com.au/trim/trim224993.pdf

2. A copy of NERA's Report can be found in Appendix 13 or on TransGrid's web site http://www.transgrid.com.au/trim/trim224991.pdf

3. The options considered by TransGrid in Appendix 4 (TransGrid Options) differ from the Options considered by NERA (NERA Options) in this Appendix 6. NERA Options are made up of combinations of TransGrid Options. To distinguish between the two in this document, TransGrid Options have been labelled numerically while NERA Options have been labelled alphabetically.

A6.1 Introduction

The AER's regulatory test states:

"An option satisfies the *regulatory test* if:

(a) in the event the option is necessitated solely by the inability to meet the minimum network performance requirements set out in schedule 5.1 of the Code or in relevant legislation, regulations or any statutory instrument of a participating jurisdiction - the option minimises the present value of *costs*, compared with a number of *alternative options* in a majority of *reasonable scenarios*;

(b) in all other cases - the option maximises the expected net present value of the *market benefit* (or in other words the present value of the *market benefit* less the present value of *costs*) compared with a number of *alternative options* and timings, in a majority of *reasonable scenarios*."

The proposed works are required to meet minimum network performance requirements to comply with the requirements of the NER and the New South Wales jurisdiction (Appendix 2). Failure to implement measures to overcome the system constraints in the required timeframe would result in the minimum network performance standards (Appendix 2) not being met. Consequently, "do nothing" would result in TransGrid not meeting its planning criteria and therefore is not an option. Only part (a) of the regulatory test was applicable. The cost or frequency of not meeting the planning criteria is not relevant to the application of part (a) of the regulatory test.

TransGrid engaged the services of a specialist economics consultant, NERA Economic Consulting (NERA) to apply the regulatory test to reasonable network and non-network options over a range of market development scenarios.

A6.2 Scenarios

The regulatory test requires that an option that satisfies the regulatory test must do so in a majority of reasonable scenarios. The scenarios developed by TransGrid and considered by NERA encompass:

- A range of demand forecast outcomes; and
- A range of different views regarding the development of new generation and/or demand management projects in relevant areas of NSW.

A6.3 Options

The options considered by NERA must address the network limitations described in Appendix 3 over a planning horizon from 2006 to 2016. No single "option" described in Appendix 4 would be sufficient; however combinations of these options may be sufficient, if constructed at appropriate times within the planning horizon.

To distinguish them from the combination options considered in the application of the regulatory test the "options" detailed in Appendix 4 are described in the remainder of this Appendix 6 as "projects" (i.e. components of combination options that may be considered by the regulatory test).

To cover periods where network projects may not be constructed in timely manner, network support via non-network projects are included within NERA's combination options. These non-network projects are not specified in detail for commercial confidentiality reasons (refer to Section A4.3 of Appendix 4). Instead, they are characterised by the amount of additional network capacity (to reliably supply the Sydney-Newcastle-Wollongong area) that they may provide and the payments that may be made to project proponents to achieve that capacity.

The options considered by NERA thus consist of:

- One or more of the network projects described in Appendix 4 constructed at appropriate times; and
- Network support capacity provided at appropriate times;

To ensure that the resultant combined options meet the network limitations described in Appendix 3 in all of the "realistic" (other than "least likely") scenarios described above.

A complete discussion of the development of these options is contained in Section 5 of NERA's report and is summarised below.

NERA initially considered a "long list" of potential options, as per the following table. Other options, discussed in Appendix 4, which could not meet the reliability criteria across a range of reasonable scenarios, were not considered further. Not investigating these options further is consistent with good electricity industry practice.

Table A6.1 Potential Options

Option No	Year	Project
Option A		no action
		500kV conversion (i.e. the "option" described in Section A4.2.1 of Appendix 4)
		no action
Option B	08/09:	Network support
	09/10:	500kV conversion
	10/11:	no action
Option C	08/09:	Network support
	09/10:	Additional network support
	10/11:	500kV conversion
Option D	08/09:	Network support
	09/10:	500kV Conversion excluding Bayswater Units 3 & 4 (i.e. the "option" described in Section A4.2.2 of Appendix 4)
	10/11:	no action

<u>Notes to Table A6.1</u>

1. The capacity of the network support projects is not specified in the above table but is determined from the requirement to address scenarios - see below.
2. The above options include other network projects that would be necessary to address emerging network limitations in the period to from 2010/11 to 2016. These consist of either the project described in Section A4.2.3 of Appendix 4 or the project described in Section A4.2.4 of Appendix 4. Whichever of these projects would be required depends on future scenarios of major generation developments in NSW. However, for a given generation development scenario the same project would be required for all options. As this project would be a common cost component of all options within that scenario, it would not affect the ranking of options. Thus for clarity these future generation development scenarios have not been defined and the later network projects have not been explicitly included in Options B and C.

NERA concluded that Options A, and D would not be included in the regulatory test calculations, as they did not meet the network limitations described in Appendix 3 for all the realistic (other than least likely) scenarios.

NERA then determined the capacity of the non-network projects in the remaining Options B and C to ensure that these options avoided the onset of network constraints in all "realistic" scenarios, determining the following two options to be assessed in accordance with the principles of the regulatory test.

Table A6.2 Options Assessed in the Regulatory Test Analysis

Option No	Year	Project
Option B	08/09:	350 MW of network support
	09/10:	500kV conversion (i.e. the "option" described in Section A4.2.1 of Appendix 4)
Option C	08/09:	350 MW of network support
	09/10:	Additional 350 MW of network support
	10/11:	500kV conversion (as in Option B but delayed by 1 year)

A6.4 Costs Taken into Account by the Regulatory Test

As this is a reliability augmentation the "least cost" limb (part (a) of the regulatory test is applied.

This requires the following costs to be taken into account:

A6.4.1 Capital Costs

Capital costs for network projects were estimated by TransGrid. TransGrid uses a rigorous process for the estimation of project capital costs based on ongoing analysis of equipment costs, market factors and project risks.

The following table summarises the estimated capital cost estimates for the network projects included in Options B and C above.

Table A6.3 Network Projects Capital Cost Estimates

Project	Estimated Cost
500 kV conversion	$320 million
Bayswater generator transformers	$30 million

Capital costs for these network projects are estimated in $2006 to ±25% accuracy.

<u>Bayswater Generator Transformers</u>

Since the time that this estimate of capital cost was prepared more accurate figures for the costs of the replacing the Bayswater generator transformers have become available. The new figure is approximately $50 million. As this figure is common to both Options considered by NERA, it will not have a material impact on the outcome of the regulatory test.

The Bayswater costs used in the regulatory test were those for reconnection of both #3 and #4 units to 500 kV. The only option considered was replacement of the generator transformers. Other higher cost arrangements (such as retaining the existing generator transformers and installing 330/500 kV transformers in series) were not considered because, being much more expensive, they could not pass a regulatory test in which simple replacement was another option.

<u>Non-network Option Costs Used in the Regulatory Test</u>

Costs for non-network projects are based on responses to TransGrid's August 2006 Request for Proposals (RFP) (refer to Section A4.3.4 of Appendix 4).

They are estimates of payments that may be made to non-network project proponents for the provision of relevant network support services.

The Newcastle/ Sydney/ Wollongong Area Application Notice was published in May 2006. At that time submissions in response to the RFP for non-network options had not been received. Consequently, NERA used an indicative cost and noted that the Final Report would use information based on responses to the RFP.

The RFP covered the summers of 2008/09, 2009/10 and 2010/11, with progressively larger amounts of Network Support being required in the later summers. It requested non-network options in the Newcastle/ Sydney/ Wollongong area, as well as the mid north coast and parts of the south coast. As non-network options in different parts of the network would vary in their effectiveness in managing the network limitations, the RFP contained geographical “effectiveness factors”.

Responses to the RFP were received from seven parties, some of whom made multiple offers. Not all offers were complete: for example some gave only indicative prices.

The initial evaluation of offers involved adjusting the amounts of Network Support offered and the prices offered by the geographical effectiveness factors. Portfolios which would deliver the required amount of network support in 2008/09 and 2008/09 plus 2009/10 were then developed. Insufficient network support was offered to enable portfolios for the summers up to and including 2010/11 to be developed.

The portfolios were based on utilising the most cost effective offers first. Consequently the portfolios covering summer 2008/09 plus 2009/10, contained offers which were significantly less cost effective than those in the portfolios covering only summer 2008/09. **Error! Reference source not found.** shows the range of costs offered (in $ per effective MW) for network support in 2008/09 and 2009/10. [It should be noted that some of these offers have since been withdrawn].

Diagram A6.1 Costs offered in response to RFP for Network Support

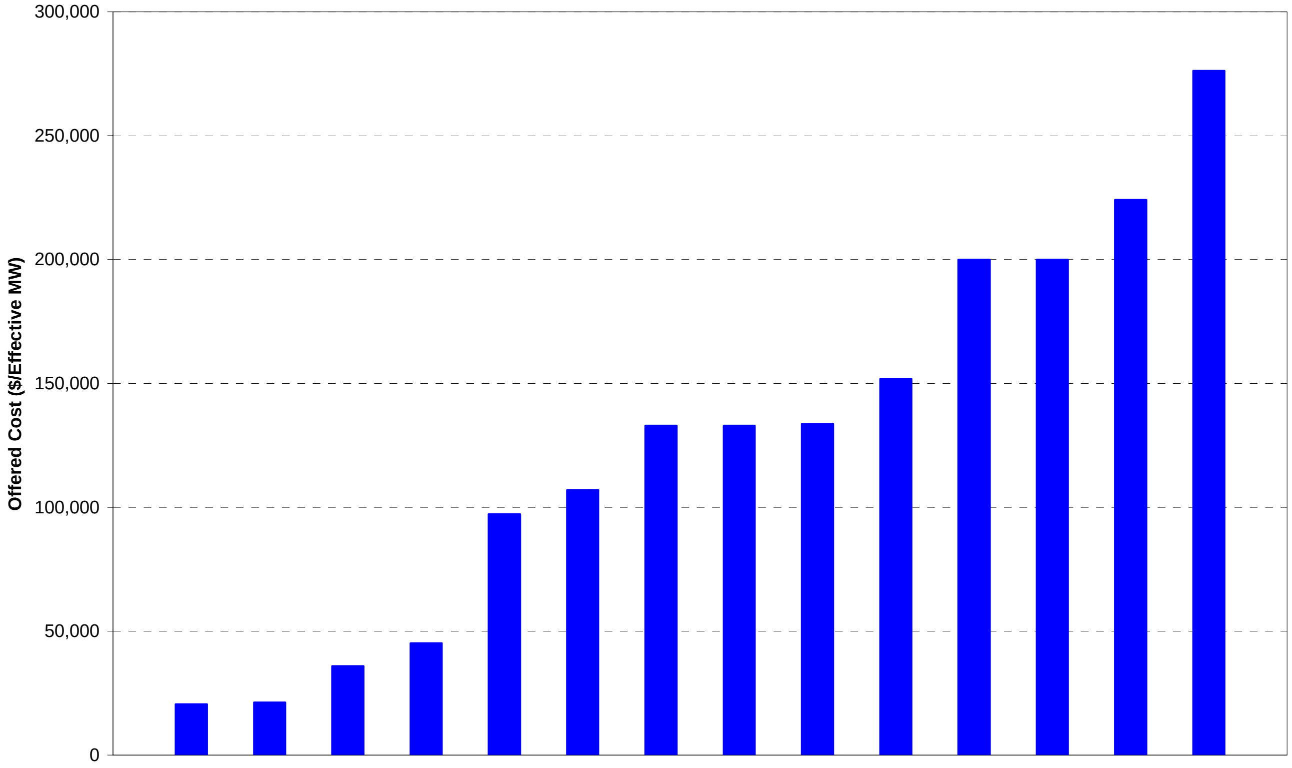


Table A 6.4 and Table A6.5 show the total costs for the portfolios developed (for the initial evaluation). [It should be noted that each of these portfolios contains offers which have subsequently been withdrawn].

Table A6.4 Portfolios for Summer 2008/09

	Total Effective MW	Total Cost ($M)
Portfolio 1	440	23
Portfolio 2	375	14
Portfolio 3	375	17

Table A6.5 Portfolios for Summer 2008/09 and 2009/10

	Total Effective MW	Total Cost ($M)
Portfolio A	776	121
Portfolio B	708	78
Portfolio C	708	70

The conclusion of the initial evaluation was that:

- network support for summer 2008/09 would cost $15 million to $20 million;
- network support for summer 2008/09 and summer 2009/10 would cost at least $70 million; and
- network support covering summer 2008/09, summer 2009/10 and summer 2010/11 was not feasible.

This information was used by NERA in their application of the regulatory test for the Final Report. NERA assumed that these payments implicitly include allowances for environmental costs and subsidies.

Table A6.6 summarises the estimated cost estimates for non-network projects that NERA included in Options B and C.

Table A6.6 Non-Network Projects Capital Cost Estimates

	2008/09	2009/10
Option B	$18 million	-
Option C	$18 million	$70 million

These costs for non-network options are estimated in $2006 to ±50% accuracy.

After the Final Report was published, additional information was sought from proponents and meeting were held with most of them. During that process, a number of proponents withdrew their offers. Consequently, the conclusions reached in the preliminary assessment are conservative.

A6.4.2 Operating and maintenance costs

These are assumed to be 2% of capital costs ±25%. This is a generic figure for annual O&M costs of transmission networks. It is consistent with the Opex cost included in TransGrid's current revenue cap. It is also used widely within Australia and internationally.

A6.4.3 Other Costs Relevant to the Case Concerned

NERA has not identified any other costs that are relevant for this proposal.

A6.5 Results

6.5.1. Base Case

Table 6.7 summarises the results of NERA's financial modelling for Options B and C under the base case of financial assumptions.

Table A6.7 Summary of Results – Base Case

Option No	Year	Project	Costs PV $M	Rank
Option B	08/09: 09/10:	350 MW network support 500kV conversion	$ 332	1
Option C	08/09: 09/10: 10/11:	350 MW network support Additional 350 MW network support 500kV conversion	$ 361	2

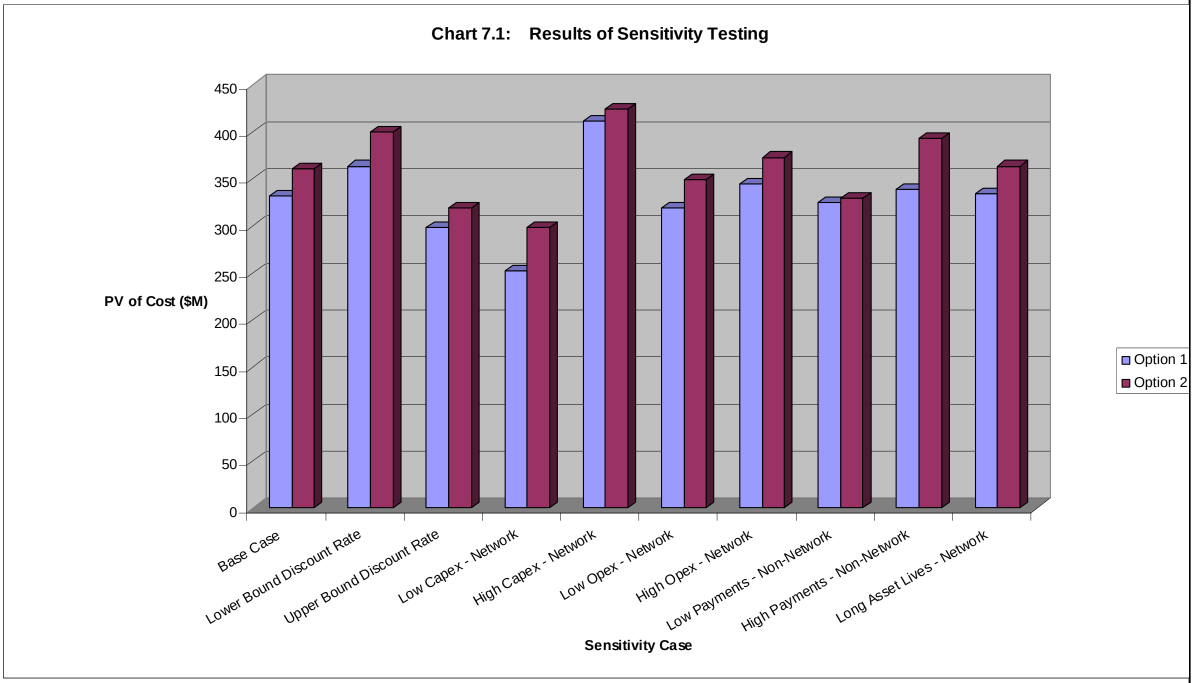
6.5.2. Sensitivity Tests

The regulatory test requires sensitivity tests to be conducted on key input assumptions. Table 6.8 details the range of key input variables used in these sensitivity tests.

Table A6.8 Range of Parameters for Sensitivity Tests

	Lower Bound	Base Case Value	Upper Bound
Discount Rate (%)	6.78	9	12
Network Project Capital Expenditure (Relative to Base Case)	-25%	-	+25%
Payments for Non-network Projects (Relative to Base Case)	-50%	-	+50%
Operating Expenditure (% of Capex)	1.5	2.0	2.5
Asset Lives Substations Lines		 30 45	 45 60

The following chart from NERA's report illustrates the present value of costs and ranking for Options B and C under the full range of "one at a time" sensitivity tests. This shows that in each case Option B is the highest ranked option i.e. the ranking of the options is robust to all reasonable "one at a time" variations in assumptions.



A6.6 Outcome of the Regulatory Test – NERA's Assessment

NERA's assessment of the outcome of the regulatory test is that Option B minimises the present value of costs compared with Option C, consequently Option B satisfies the regulatory test (refer to NERA's report page 1).

A7 Appendix 7 - Description of Least Cost Option

As shown in Appendix 6 the least cost option is a combination of network support and network augmentation. The components of this option are

A7.1 Western 500kV Conversion

- 350MW of network support in the Sydney-Newcastle-Wollongong area (summer 2008/09)

- At Bayswater (summer 2009/10 and summer 2010/11):
  - Establishment of a 500kV switchyard at Bayswater adjacent to the existing 330kV switchyard;
  - Connection of the two switchyards by two 500/330kV transformers;
  - Connection of two 150 MVAr shunt reactors to the transformer tertiaries;
  - Reconnection of the existing Mt Piper/Wallerawang line at Bayswater to the 500kV switchyard (the remote ends are to be reconnected to Mt Piper and Wollar); and
  - Reconnection of generator unit 4 at Bayswater from the 330kV switchyard to the 500kV switchyard. (April 2009 - to meet agreed generator outage date)
  - Reconnection of generator unit 3 at Bayswater from the 330kV switchyard to the 500kV switchyard. (April 2010 - to meet agreed generator outage date)
    NOTE: Reconnection of Bayswater Unit 3 and 4 generator transformers is the subject of this Pass-Through Application.

- At Mount Piper (summer 2009/10):
  - Establishment of a 500kV switchyard at Mt Piper adjacent to the existing 330kV switchyard;
  - Connection of the two switchyards by two 500/330kV transformers;
  - Connection of two 150 MVAr shunt reactors to the transformer tertiaries;
  - Reconnection of the existing Bayswater circuit from the 330kV switchyard to the 500kV switchyard;
  - Connection of a Wollar circuit to the 500kV switchyard;
  - Reconnection of the existing Marulan line from the 330kV switchyard to the 500kV switchyard;
  - Connection of the existing 330kV circuit, which presently connects one of the 500kV circuits to Bayswater, to Mount Piper to form a second Mount Piper – Wallerawang 330kV circuit; and
  - Relocation of the existing Wellington line within the 330kV Switchyard.

- At Bannaby (summer 2009/10):
  - Establish a new 500/330kV substation including 500kV and 330kV switchyards, two 500/330kV transformers and two 150 MVAr shunt reactors connected to the transformer tertiaries;
  - Connect two 500kV circuits to Mount Piper; and
  - Connect 330kV circuits to Yass, Sydney West and two to Marulan.

- At Wollar (summer 2009/10):
  - Convert 500kV switchgear operating at 330kV to 500kV operation;
  - Install a 500/330kV transformer and 330kV switchbay; and
  - Reconnect the Wellington 330kV circuit to the new 330kV switchbay.

Additional works that form part of this option are as follows:

- At Wallerawang 330kV Switchyard (summer 2009/10):
  - Uprate equipment to ensure adequate fault level ratings.

- Carry out uprating works on the following 330kV circuits (summer 2009/10):
  - Marulan – Avon;
  - Marulan – Dapto; and
  - Kangaroo Valley – Dapto.

- Modify 330kV line protections in the Bayswater – Liddell area (summer 2009/10).

A7.2 Reconnection of Bayswater Units 3 and 4 Generator Transformers

The following works are to be carried out by April 2009 (to meet agreed generator outage date):

- Disconnect Unit 4 generator transformer overhead connections from the 330kV switchyard;
- Dismantle 330kV overhead connections from the 330kV switchyard to the Unit 4 generator transformer;
- Dismantle and remove Unit 4 generator transformer (2 transformers);
- Dismantle and remove the backup generator transformer (1 transformer);
- Modify the generator transformer location to accommodate the new generator transformer;
- Install the new Unit 4 generator transformer (2 transformers);
- Install a new backup generator transformer(1 transformer);
- Construct new overhead connections from the Unit 4 generator transformer to the 500kV switchyard;
- Connect Unit 4 generator transformer overhead connections to the 500kV switchyard;

The following works are to be carried out by April 2010 (to meet agreed generator outage date):

- Disconnect Unit 3 generator transformer overhead connections from the 330kV switchyard;
- Dismantle 330kV overhead connections from the 330kV switchyard to the Unit 3 generator transformer;
- Dismantle and remove Unit 3 generator transformer (2 transformers);
- Modify the generator transformer location to accommodate the new generator transformer;
- Install the new Unit 3 generator transformer (2 transformers);
- Construct new overhead connections from the Unit 3 generator transformer to the 500kV switchyard;
- Connect Unit 3 generator transformer overhead connections to the 500kV switchyard;
- Dispose of removed generator transformers (5 transformers).

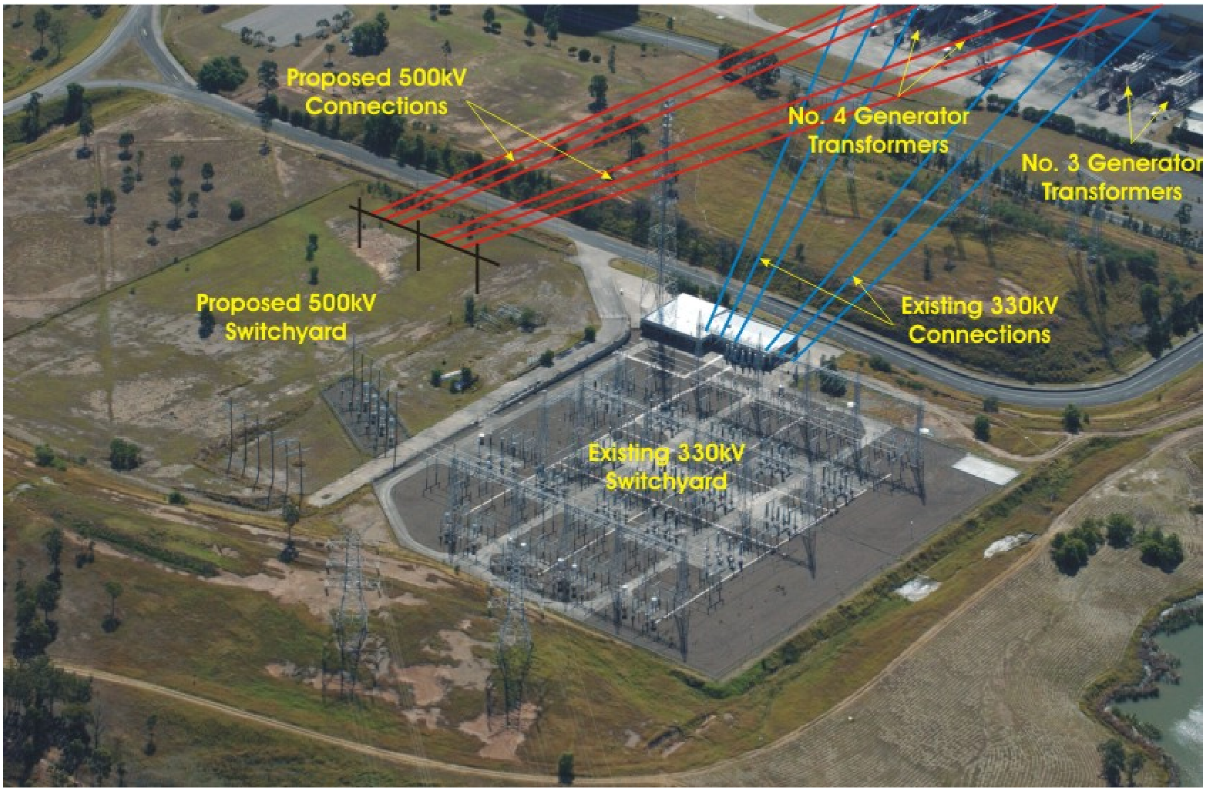
A7.3 Impact on System Capability

Conversion of the Bayswater - Mt Piper - Marulan line to 500kV operation will increase the power carrying capacity of this line. Increasing the voltage of this line also reduces the relative impedance of this line compared to the others in the system and thus more power will flow via this line than prior to the change in voltage. Connection of two generating units to 500kV rather than 330kV at Bayswater will also force more power to flow over the 500kV line and less over the remaining 330kV lines.

On completion of the Western 500kV Conversion, more power will flower from the Hunter Valley area and north (Queensland interchange) to the major load areas in the Newcastle - Sydney - Wollongong area via the 500kV system and less over the remaining 330kV lines. This will alleviate the thermal constraints on lines between the Hunter Valley and Newcastle as well as the voltage constraints in the Sydney area.

A8 Appendix 8 - Aerial Photographs

Bayswater 330kV Switchyard and Bayswater Power Station showing units 1 to 4 generator transformers.

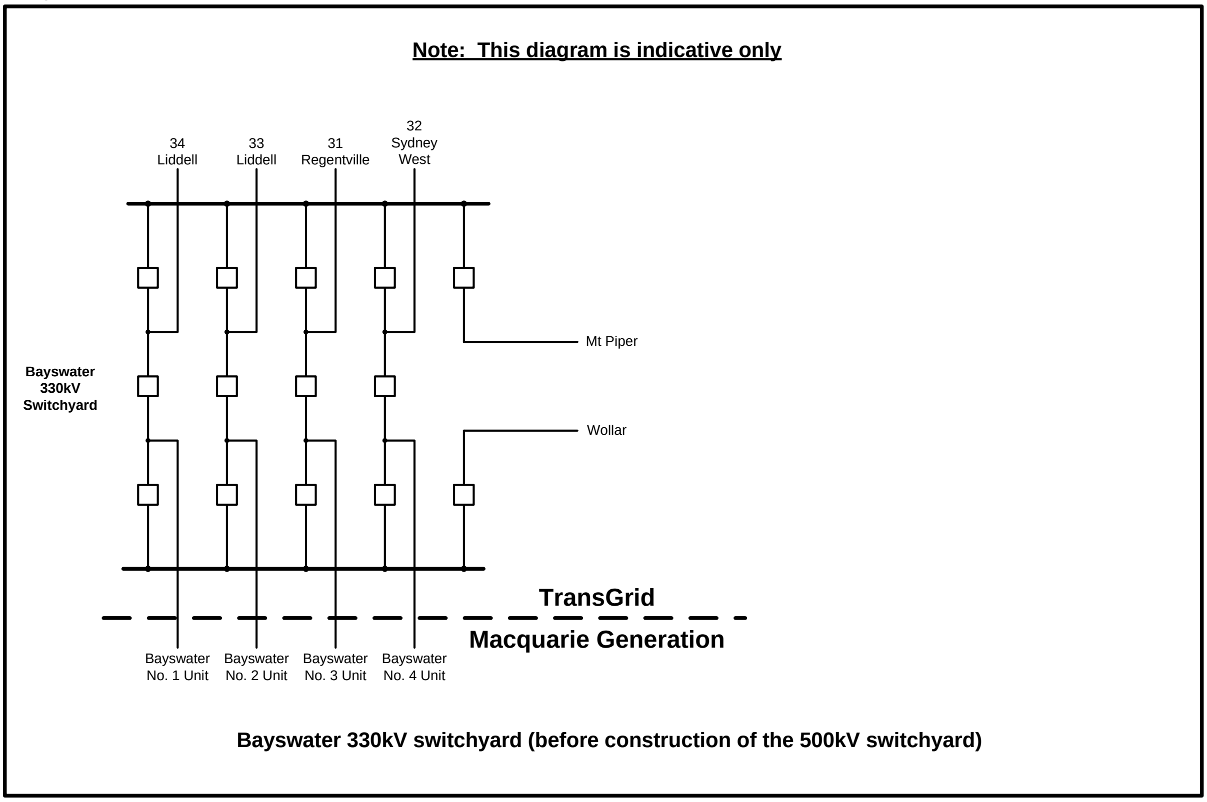


Proposed reconnections at Bayswater.

A9 Appendix 9 - Schematic Diagrams

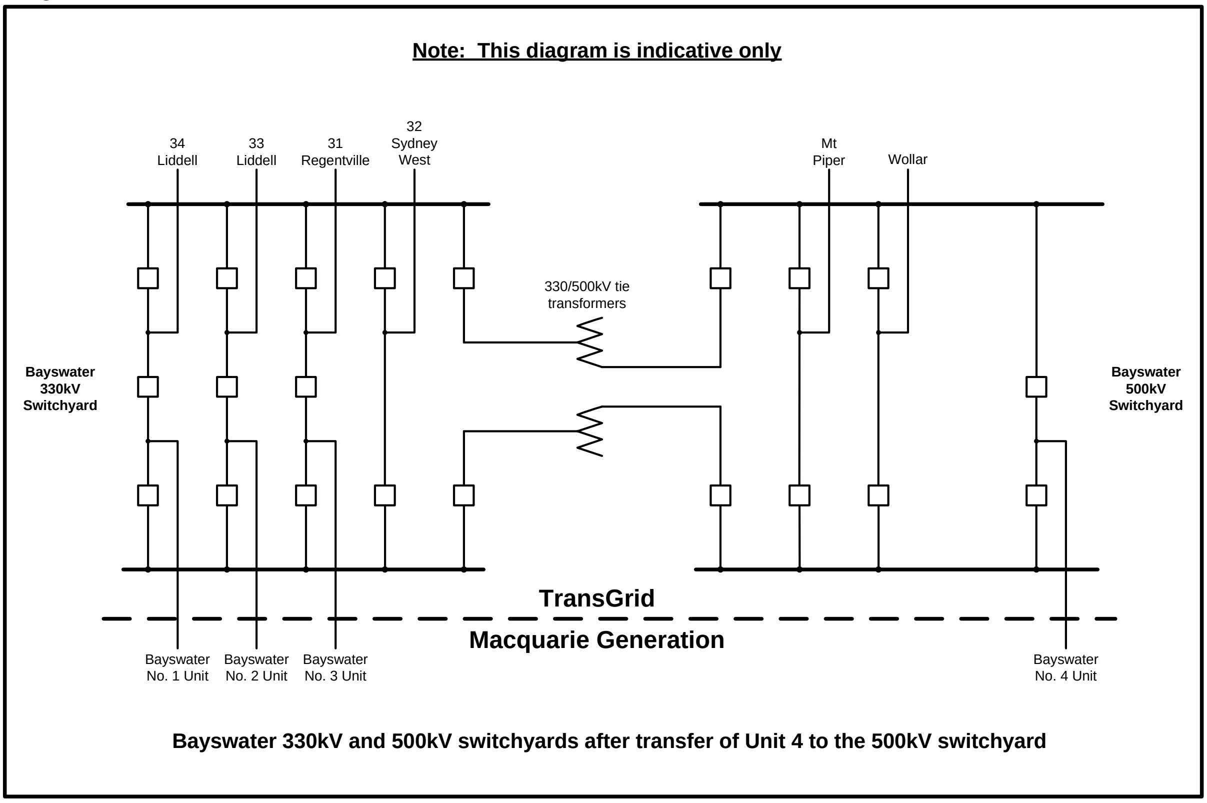
The following diagrams show the staging of the transfer of connections for units 3 and 4 from Bayswater 330kV switchyard to Bayswater 500kV switchyard.

Diagram A9.1



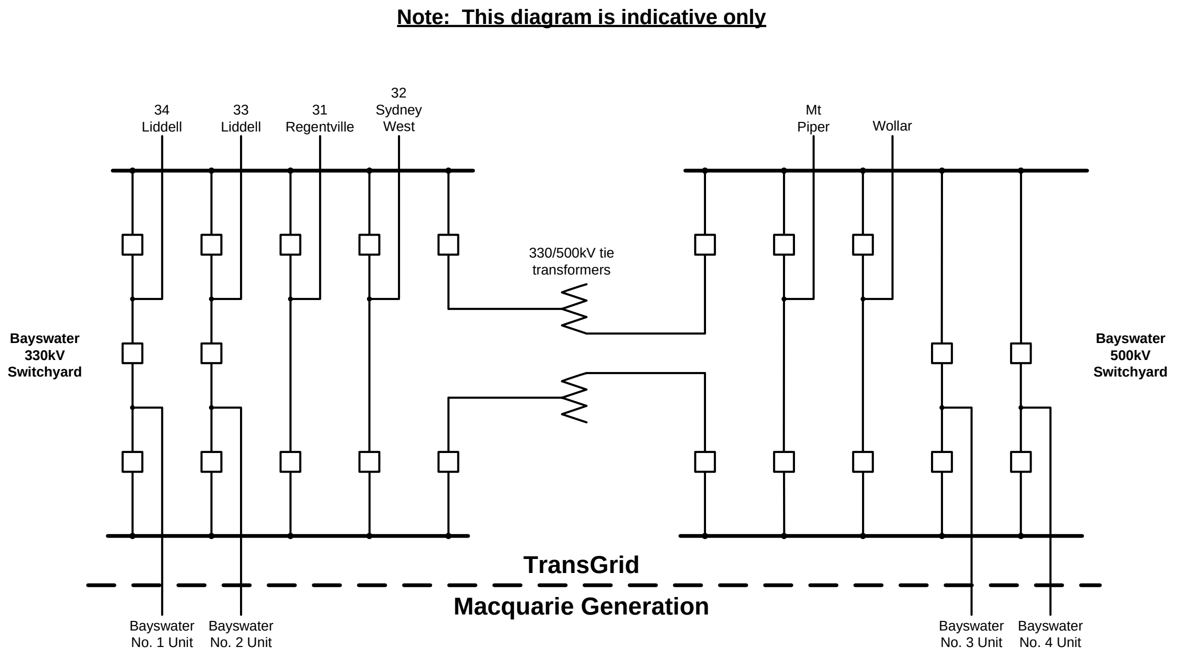
Bayswater 330kV switchyard (before construction of the 500kV switchyard)

Diagram A9.2



Bayswater 330kV and 500kV switchyards after transfer of Unit 4 to the 500kV switchyard

Diagram A9.3



Bayswater 330kV and 500kV switchyards after transfer of Units 3 & 4 to the 500kV switchyard

A10 Appendix 10 – TransGrid's Costs - Methodology

TransGrid's Operating Costs

These are actual recorded costs up to 25th July 2007.

Legal expenses			
Gilbert & Tobin, Lawyers			$25,239
TransGrid's labour costs	Hrs	Rate ($/hr)	Amount
Expert Engineer/Accountant etc	210	205	$43,050
Specialist Engineer/Accountant etc	280	170	$47,600
		Total	**$115,889**

TransGrid's Financing Charges

Assumptions:

1. TransGrid makes the first payment of $5M to Macquarie Generation on 1st July 2007.
2. TransGrid makes the second payment of $25M to Macquarie Generation on 1st April 2009.
3. TransGrid will recover both amounts over the 2008/09 regulatory year.
4. The first recovery amount will be received on 1st September 2008 and the last recovery amount on the 1st August 2009. (TransGrid issues invoices for TUOS for a given month at the start the next month. Payments are not received until the start of the month after that).
5. Financing charges are calculated using the Reserve Bank of Australia 90 Day Bill rate as at 23rd October 2007 = 6.85%

TransGrid will incur financing charges on the first payment ($5M) from 1st July 2007 until 1st August 2009. TransGrid will accrue interest on the second payment ($25M) recovery amounts from 1st September 2008 until 1st April 2009. TransGrid will incur financing charges on the second payment ($25M) from 1st April 2009 until 1st August 2009

First Payment Financing Charges

The outstanding amount that need to be recovered starting 1st September 2008 (14 months after paying out the $5M) can be calculated using Microsoft Excel Function:

FV(rate,nper,pmt,pv,type)

where

rate is monthly interest rate = RBoA 90 Day Bill rate / 12
nper is the number of months between TransGrid paying the $5M and the start of the recovery period. (14 months)
pmt is the monthly payment amount = 0
pv is the TransGrid payment amount = $5M
type is 0

This amount is the amount owing at the start of the recovery period.

rate	6.85% (As at 23rd October 2007)
nper	14
pmt	0
pv	$5,000,000
type	0
FV	**$5,414,753.45**

The equal Monthly Recovery Payments required to recover the amount above in a 12 month period can be calculated by using Microsoft Excel Function:

PMT(rate,nper,pv,fv,type)

where

rate is monthly interest rate = RBoA 90 Day Bill rate / 12
nper is the number of payment periods = 12
pv is the amount that need to be recovered and is equal to the amount FV calculated above.
fv is the balance after the last repayment = 0
type = 0

The total repayments will be the Monthly Recovery Payments multiplied by 12. The financing charges will be this amount less TransGrid's original payment amount.

rate	6.85% (As at 23rd October 2007)
nper	12
pv	$5,414,753
fv	0
type	0
PMT	**$468,146.65**

Total repayments **$5,617,759.80**

Financing charges **$617,759.80**

Second Payment Financing Charges

TransGrid will be accruing interest on recovered amounts from 1st September 2008 up until 1st April 2009. The total amount recovered up to that date can be calculated using Microsoft Excel Function:

FV(rate,nper,pmt,pv,type)

where

rate is monthly interest rate = RBoA 90 Day Bill rate / 12
nper is the number of months between the start of the recovery period and TransGrid paying the $25M (8 months)
pmt is the monthly payment amount
pv is the TransGrid payment amount = $5M
type is 0

This amount (**FV1**) will be a function of the monthly repayments **PMT**. At 1st April 2009, TransGrid will need to pay out $25M. Thus, it will need to borrow $25M-FV1. There will be financing charges on this amount borrowed until the amount is fully recovered. These financing charges can be calculated using Microsoft Excel Function:

FV(rate,nper,pmt,pv,type)

where

rate is monthly interest rate = RBoA 90 Day Bill rate / 12
nper is the number of months between TransGrid paying the $25M and the end of the recovery period. (4 months)
pmt is the monthly payment amount and is the same as used to calculate FV1 above
pv is the amount at the start of the period ($25M-FV1)
type is 0

The final value FV2 derived from this function must be zero. Using the "Goal Seek" tool in Excel, the equal monthly repayments required to give PV2=0 can be calculated.

rate	6.85% (As at 23rd October 2007)
nper1	8
pmt	$2,065,222.52
pv1	$0
type	0
FV1	$16,855,667.12

And pv2 = FV1 - $25M

nper2	4
pmt	$2,065,222.52
pv2	-$8,144,332.88
type	0
FV2	$0.00

Total repayments **$24,782,670.24**

Interest accrued **$217,329.76**

<u>Summary of Payments and Financing Charges</u>

Payment Date	Payment Amount	Associated Financing Charges *	TransGrid Overhead Costs	Total Additional Charges	Total Pass Through Amount
01-Jul-07	$ 5,000,000.00	$617,759.80	$115,889.00	$733,648.80	$ 5,733,648.80
01-Apr-09	$25,000,000.00	-$217,329.76		-$217,329.76	$24,782,670.24
	$30,000,000.00	**$400,430.04**	**$115,889.00**	**$516,319.04**	**$30,516,319.04**

* + indicates interest charges incurred
- indicates interest earned.

A11 Appendix 11 - SKM Report on Project Management Fees

Sinclair Knight Merz
100 Christie Street
PO Box 164
St Leonards NSW
Australia 1590

Tel +61 2 9928 2100
Fax +61 2 9928 2500
Web www.skmconsulting.com

Dr Ashok Manglick / Ian Hartley
TransGrid
201 Elizabeth St
Sydney NSW

3 December 2007

HA01055 - Review of PM Estimate (rev 1).doc
HA01055

Dear Dr Manglick,

Review of Project Management Cost Allocation on the Reconnection of Bayswater Units 3 and 4 to the 500kV Switchyard Project

1. Background

The Australian Energy Regulatory (AER) has requested TransGrid provide an independent review of the project management allocation on one of the projects that is currently being assessed as part of a regulatory test. SKM has been commissioned by TransGrid to undertake this review.

The project involves upgrading a number of transformers at Bayswater power station to facilitate TransGrid's planned 500kV network upgrade.

The scope of the project for which the project management covers is as follows.

- Procurement of 5 new generator transformers - 2 per generating unit plus 1 spare;
- Removal of the existing transformers (5);
- Civil works etc associated with any necessary changes to the generator compounds;
- Installation of the new transformers (5);
- Dismantling of the old overhead connections from the generator transformers to the 330kV switchyard (2);
- Construction of new overhead connections to the 500kV switchyard (2); and
- Disposal of the removed transformers

The project is anticipated to take approximately 3 years to complete.

The Bayswater power station is owned and operated by Macquarie Generation. A Connection Variation Agreement (CVA) has been drawn up between TransGrid and Macquarie Generation to cover the commercial aspects of the project. TransGrid will fund the project and Macquarie Generation will undertake the project work.

The purpose of the review is to provide an independent assessment of a typical project management allocation for this type of project.

2. Review of Project Delivery Allocation

In preparing estimates for medium to long term capital works projects, SKM has traditionally applied a project delivery allowance to account for planning and preliminary costs, design costs and project management. In general, these costs are collated into an engineering, procurement and construction management (EPCM) allowance.

Based on SKM's experience with project estimates and asset valuations in the electricity industry an EPCM allowance of around 15% is considered reasonable for projects of this type.

The typical breakdown that SKM would consider for the EPCM costs is:

- 1-2% for planning and preliminary costs;
- 4-5% for design and engineering; and
- 9-10% for project management

Typically, the project management component captures costs associated with activities such as:

- Procurement management;
- Construction management;
- Contract management and administration;
- Operational costs;
- Environmental management; and
- Development approvals

The cost allocation categories provided by TransGrid are shown in Table 1.

SKM

Table 1 – Cost Allocations Categories

	Description
1	New generator transformers (5 units)
2	Existing generator transformer removal and disposal
3	Overhead connections
4	Macquarie Generation project risk margin and project management fee
5	Compensation for potential commercial losses for locked-in outages
6	Old transformer agreed value (credit)

SKM has not been provided with a detailed cost estimate for the project and as such is unable to comment on the tasks and allocation of costs within the project management allowance. From the coarse allocations of costs in the schedules, it cannot be determined where the engineering / design costs and preliminary planning costs are allocated. In the event that design and preliminary planning costs are allocated to the project management fee, TransGrid's allowance of around 9% for these tasks inclusive of project management would on the surface appear to be below the typical industry average.

Item 4 in Table 1 includes a project risk margin. A project risk margin (risk factor) is included to take account of risks that are outside of the control of TransGrid and Macquarie Generation when estimating the project. Historically, the AER generally accepts that there is a tendency for outturn costs to be greater than forecast costs due to unforeseen factors at the time of preparing project cost estimates. In its recent transmission determinations for ElectraNet and Powerlink, the AER has applied a 2.6% risk factor across the suite of capital projects. As the risk margin is not specifically related to project management, it should ideally be separated to ascertain the actual amount allocated to project management. The effect of removing an assumed 2.6% risk factor from the project management allocation is shown in Table 2.

SKM notes that item 5 in Table 1 makes consideration for compensation for commercial losses as a result of locked-in outages. When assessing the project management allocation for the project, SKM considers it unreasonable to include this cost in the capital cost of the project from which the project management allocation is typically derived. Table 2 shows the project management allocations with the compensation included and excluded for comparison.

SKM

- Table 2 - Project Management Allocations

Compensation component	2.6% Risk Margin	Project Management as Percentage of Capital
Included	Included	8.7%
Excluded	Included	10.3%
Included	Excluded	8.9%
Excluded	Excluded	10.6%

3. Conclusions

Given the information available, SKM considers that the most accurate capital cost for the project is determined by removing the compensation component and the risk margin. The impact of this on the project management allocation is an increase from 8.7% to 10.6%. In terms of overestimating the project management component, the worst case would be that the design / engineering and preliminary planning costs are excluded. Even in this case, SKM considers that the project management allocation is reasonable for undertaking a project with this scope.

SKM considers that an overall allowance for project management of 15% (including all aspects of EPCM) is a typical industry value for undertaking projects of this nature. Depending on the allocation of costs to the total capital cost, TransGrid's estimate of between 8.7% and 10.6% appears to be reasonable.

Yours sincerely

[by email]

Ryan Dudley
Senior Consultant - Power
Phone: 9928 2462
Fax: 9928 2506
E-mail: RDudley@skm.com.au